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CONTENTS.

ILLUSTRATED ARTICLES: PAGE.

Designing Dynamos and Motors ... 262
Weston's New Measuring Instruments ... 263
The Gerard Arc Lamp ... 264
A New System of Simultaneous Telegraphy and Telephony ... 264
The Heroult Aluminum Process ... 265
On the Measurement of Electricity in a House-to-House Supply ... 267
The National Underground System ... 268
The Richards Oil Engine for Small Lighting Plants ... 268

CORRESPONDENCE:

Disruptive Discharges in Cables ... 268

EDITORIAL:

Paragraphs ... 261

MISCELLANEOUS:

Sale of the Waterhouse System ... 263

MISCELLANEOUS: PAGE.

New Sprague Road at Akron, Ohio ... 266
The Importance of Condensing Apparatus in Electric Light Stations ... 266
Filtration of Mercury ... 268
An Electric Tram Car in Paris ... 268
Proper Tests for Non-Magnetic Watches ... 269

SPECIAL CORRESPONDENCE:

New York Notes ... 269
New England Notes ... 269
Philadelphia Notes ... 270
Western Notes ... 270

DEPARTMENTS:

The Telegraph ... 271
The Telephone ... 271
The Electric Light ... 271
Applications of Power ... 271
Personals ... 271
Miscellaneous Notes ... 271
Business Notices ... 272
Our Illustrated Record of Electrical Patents ... 272

Cabling the News. THE day after our great Presidential election, the New York *Herald* added to the number and variety of its journalistic feats by putting its Paris edition into London with a full report of the result and complete returns up to the hour of going to press. The cable messages sent were the longest and fullest ever transmitted from this country to Europe, and the paper was perfect in all its other features, being simply a Europeanized *Herald*. We note that the journal, in speaking of its achievement, is generous in its praise of the service rendered by the Commercial Cable Company, and those who know how well Mr. Ward and his staff do their work can readily believe that it was clean, brilliant and unsurpassable on this notable occasion. We suppose that a Paris and London issue of the *Herald* will now be the regular thing, and with the help of well-handled cables it ought to be no great difficulty for a journal of such enterprise and resource.

Navigation Lights. WE had occasion to comment a short time since on the downright spite which had been shown by some mariners against the electric light. It will be remembered that the National Board of Steam Navigation proposes to get the aid of Congress, which is to pass a law fining anybody who shall venture to put decent lights on a bridge or alongshore. Possibly the $100 fine proposed may effect what is wanted, but it cannot do much to raise the standard of seamanship. We notice that the captain of a schooner which came in disabled last week, alleged that the new incandescent buoy lights in Gedney's Channel were the cause of his mishap. There is no hope for such cases. We all know how terrific the glare of a 100 c. p. incandescent light is, and if the weak eyes of some of our seagoing folk can't stand so intense an illumination, the lights must go. But when they are gone, ready-made excuses for bad navigation will also have gone, a fact that such people, near sighted in more than one way, appear to forget.

A New Cause of Lunacy. ACCORDING to a medical expert, who has been giving to the newspapers some talk on the increase of lunacy, the telephone is one of the new agents in driving men mad. People are put into a dangerous nervous state by the inventions and conveniences of these modern times, and the telephone does its share in destroying men's nerves and brain by the condition of worry it induces. We are very much inclined to challenge flatly this expert's opinion, and we should be glad—or sorry—to know of the first case of insanity that can be directly attributed to the use of the instrument. Those who might be most affected are the charming young ladies who preside at the switch-boards of our exchanges, and whose suave responses to the hurried call often bring calm to the agitated breast. The only trouble with them is that they get married very quickly; but perhaps the medical expert would only regard that as a confirmation of his theory.

Extracting Aluminum. NOTWITHSTANDING the oft-repeated heraldings of the successful commercial production of aluminum, that metal still maintains its place among the rarer metals, and is only employed in the pure state when special circumstances require it. But though valuable in its pure state, it has, nevertheless, risen to considerable importance and is destined to wide application, when combined with other metals as an alloy, and for this advance the engineering world is undoubtedly indebted to the work of the electrician. Although isolated attempts with comparatively weak currents had been made in the past, and small quantities of metal such as steel were raised to the point of fusion, the true commercial electric furnace is the creation of the last few years. The criticism is sometimes heard that the electric furnace has not yet produced pure aluminum. While this is essentially true, it is not hazarding much to assert that the end will finally be reached, and probably at no distant day. The article descriptive of the Heroult process for extracting aluminum points out a new direction in which to work in this field, and that is the utilization of the electrolytic action which has been found to take place with metals in the molten state, in which, as in the ordinary electrolytic bath, the molecules have a large freedom of motion.

Electrics and the Election. WHILE a scientific paper is by its very nature slow to discuss or touch upon political issues, as being beyond its legitimate province, it may not be out of place to make the remark that the recent election has probably been one of importance to the electrical industries of the country. Opinion on the point, in electrical circles, has been by no means unanimous, but in several leading departments anxiety has been felt lest Mr. Cleveland's low tariff utterances should be approved by the popular vote. Now that the Democrats have sustained defeat on that issue, there should be a more sanguine feeling, and that in turn must lead to greater industrial activity. At the same time we should not be surprised, even under the new régime, to see a movement towards procuring cheaper raw materials, some of which are highly necessary to the electrical business. In regard to the local result in New York City, perhaps electrical concerns are not likely to feel so happy. Mr. Grant, the incoming Mayor, has pledged himself in strong terms to the removal of the wires and the furtherance of the subway work, and thus the lighting companies will have to encounter enmity in a quarter from which they have hitherto had little but cordial co-operation and support. If Mayor Grant were not the nominee of Tammany Hall, we might feel more hopeful as to the new conditions, but all that can be done is to wait and see how he will carry out the ideas with which he enters office.

Simultaneous Telegraphy and Telephony. WE give in another column a description of a new system of simultaneous telegraphy and telephony, devised by Dr. W. W. Jacques, embracing in its organization the use of the Muirhead condenser, which contributed largely to the practical success of duplexing ocean cables. America is usually so quick at taking up any improvement, that it seems worth while to inquire into the reasons which have thus far prevented the application of simultaneous telegraphy and telephony over the same wire here, in the face of the fact that the system is in successful operation abroad. Looking at it from the electrical standpoint, it may be argued that such traffic requires specially constructed lines, which involves expense in the first place; and that with a large number of wires already connected, all our large cities have both kinds of service firmly established and an addition to that number for this particular purpose may not seem advisable at the present time. But we can also safely assume that reasons other than electrical have thus far stood in the way in the adoption of the system here. The telephone and the telegraph are practically in the hands of two individual corporations, which, though serving the public to the same end, find themselves in a position in which one cannot well work the field of the other except by special agreement; and that state of things may continue for some time. It is little to be wondered at that the simultaneous transmission of telephone and telegraph messages has made no progress in this country, though its practicability may now be said to be well established.

Alternating Current Meters. WE have arrived at a most interesting stage in the problem of registering the consumption of current in houses where the alternating system is employed. The meter at present most extensively used in the direct system of supply is based on the electrolytic method; but at the outset this method was rejected for the alternating system, for the reason that, as formerly supposed, the alternating current could not be employed in electrolysis. In the light of recent investigation, however, this idea must disappear, for, as has been shown conclusively, the alternating current can, under suitable conditions, be employed in depositing in an electrolytic bath. But the lack of this knowledge has given rise to a number of other forms of meters for the alternating current, among which we need only mention those in which the production of heat by the current is employed, and one in which an alternating current motor is caused to register in proportion to the current passing through the circuit. But there is still another which has recently been brought out in England and which is described on another page. In this system, the student will notice, the registration of the current for meter purposes is effected by the interposition of a constant E. M. F., which increases the strength of the alternating impulse in one direction, and decreases it in another, so that this form of current, passing through an electrolytic bath, effects a deposition. The author mentions the storage battery as the source of constant potential employed for this purpose, but we are not informed what the effect of the alternating current is upon the storage battery, nor whether it remains constant in its action for continuous periods under the conditions stated. The author also cites a number of other methods which may be applied to the similar purpose of metering alternating currents, such as an electromagnet whose core is magnetically saturated, so that only such current impulses affect it which tend to reduce its magnetism.

The Electric Light Association. THE Secretary of the National Electric Light Association, Dr. A. V. Garratt, has issued a circular letter to all the manufacturers and dealers of apparatus and supplies in the association, inquiring their views as to certain matters connected with the semi-annual meetings. He makes three suggestions: 1. Whether it would not be well to have a general exhibition room, furnished with power, where all exhibits may be advantageously displayed. 2. Whether it would not be wise to close all the exhibition rooms while the sessions are being held; and 3. Whether it would not be desirable to set apart one day exclusively for exhibition purposes, the convention not to assemble on that day. These are three very interesting and important points, which deserve consideration. As a matter of fact, what are known as the "supply men" are practically in a majority in the association. This is contrary to the practice of many similar bodies, from which supply men are expressly excluded as active members. Yet we must say that the broader platform of the Electric Light Association commends itself to our judgment, since it insures a financial support that otherwise would be difficult to obtain, and it certainly begets a more general interest in the welfare of the organization. It being the fact, therefore, that the supply men can, so to speak, run the association, it would evidently be their best policy to assist the Executive Committee and Dr. Garratt on such lines and in such a way that the meetings shall be made as intrinsically attractive as possible; and we doubt if there be a manufacturer or dealer who does not desire to see the interest in the association and the attendance at its gatherings grow from year to year. It seems to us that the suggestions made in the circular tend to meet various objections to the present method of conducting affairs at the meetings, and that, if adopted, they will answer their purpose fully. We trust that our manufacturing and supply friends will give their thoughtful consideration to the questions put them by Dr. Garratt, and will give him all the help they can.

Designing Dynamos and Motors.

BY R. B. OWENS.

The impression still prevails among many mechanical and civil engineers, as well as the general public, that there is about dynamo and motor building something both mysterious and uncertain, and that the designing of a dynamo machine to give a certain predetermined output is for a large part a matter of guesswork. Perhaps the electrical engineers of to-day can pardon this erroneous idea, considering that it was the custom, but a few years ago, among *practical* electricians to roughly guess from the dimensions of some similar machine about what the dimensions should be so as to give the required output, and, after the dynamo was built, to change the speed or winding of the field magnets until the required conditions were fulfilled. If this did not answer, another machine was built until the desired object was attained.

In this short paper I shall endeavor to correct the prevailing impression by showing that all our formulæ of construction are in a very simple manner derived from *experiment*, the only truly scientific method of investigation. To start with an experimental fact, we may state that by a transverse motion of a conductor in a magnetic field the said conductor has an electromotive force generated in it. This fact was first discovered by Faraday in 1831, and has since become the basis of nearly all electro-mechanical investigations, a more fundamental principle not being needed in practice.

It is also an experimental fact that the same magnet, when placed in different magnetic fields, is acted on by different forces, and a unit magnet pole is defined as that which, placed at a distance of one centimetre from a like magnet pole, repels it with a force of one dyne; hence the intensity of a magnetic field has been taken to be numerically equal to the force in dynes with which a unit magnet pole is acted on when placed in this field. The conventional mode of representing such a field is to draw, or imagine drawn, a number of lines equidistant and so spaced that the number cutting unit area of any plane at right angles to the direction of the lines numerically equals the intensity of the field. This mode of representation is very convenient, as will be seen further on.

Physicists observing the electromotive force in the moving conductor to vary as its length, velocity, and the intensity of the field in which it moved, and also being desirous of establishing some general system of units, most naturally define unit electromotive force as that which is generated in a conductor one centimetre in length, moving with a velocity of one centimetre per second, and in a field having an intensity of one dyne, the motion being at right angles to the lines of force. Unit current is defined as that which, flowing in a conductor one centimetre in length, at a distance of one centimetre from unit magnet pole, acts on this pole with a force of one dyne.

The question which next presents itself after defining unit electromotive force and unit current is the determination of the energy of a current C flowing under a difference of potential or electromotive force E. To fix ideas, suppose we have a large metallic sphere charged with a certain amount of positive electricity and also a small gilded pith ball charged with unit quantity of positive electricity. Now, according to Sir William Thomson, the electrical potential of the sphere numerically equals the amount of work done in bringing the pith ball from an infinite distance (when of course the force between the sphere and ball is zero) up to the sphere. If, however, instead of starting from an infinite distance, we had started from another sphere having a different potential from the first, the mechanical work expended in transferring our pith ball from the one to the other, would numerically equal the difference of potential between the two spheres. It is also evident that had the pith ball contained two, three or more units, the mechanical energy expended would have increased in the same ratio. Hence, it follows that the mechanical energy required to transfer q units of electricity from a sphere or point where the potential is p_1 to a sphere or point where the potential is p_2 (p_2 being greater than p_1), is $q(p_2 - p_1)$; and the result would not be altered if, instead of the transfer taking place by the aid of our pith ball, carrying a definite amount of electricity q, it were to take place by means of a wire carrying a continuous current, since the latter may be considered as a succession of pith balls. Hence, we see that the power of a current C flowing under a difference of potential E is $E\,C$. If E is measured in volts instead of absolute units, and C in ampères instead of absolute units of current, then the product $E\,C$ is measured in watts; one watt $= 10^7$ ergs per second.

Having these preliminary considerations clearly in mind, the whole theory of dynamo and motor construction may be easily and simply evolved. Consider a single wire, of length d, on the armature of a dynamo, the wire moving at right angles to the lines of force with a velocity v, and in a field of intensity H. The electromotive force generated in this wire is, from the definition of unit electromotive force, evidently $E = H\,d\,v$. If the diameter of the armature is $2\,r$, then at a speed of n revolutions per minute the velocity,

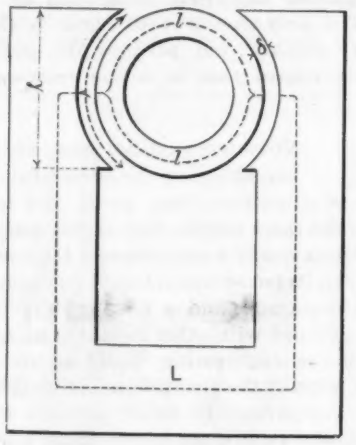
$$v = 2\,\pi\,r\,\frac{n}{60};\ \text{hence,}\ E = 2\,\pi\,r\,H\,d\,\frac{n}{60}.$$

But $2\,r\,d$ is the total space swept over by the wire, and $2\,H\,r\,d$ is the total number of lines of force passing through the space. Calling this number Z, we have for the maximum electromotive force the expression $E = \pi Z\frac{n}{60}$. But since during one-half revolution the electromotive force decreases from maximum to zero and increases again to maximum, it becomes of importance in practice to determine that mean electromotive force which, acting for the same time as the variable one, will cause the same amount of electricity to flow through the circuit.

This may be done as follows: Let the position of the wire at any moment be defined by the angle α which it makes with the line joining the poles of the field magnets, and in a time dt, let it advance through an angle $d\alpha$. The quantity of electricity which flows through the circuit of resistance R is evidently $dq = \frac{H\,d\,v\sin\alpha\,dt}{R}$

But $v = r\,\frac{d\alpha}{dt}$; and therefore, $dq = \frac{H\,d\,r\sin\alpha\,d\alpha}{R}$.

Integrating between the limits zero and π we have $q = \frac{2\,H\,d\,r}{R}$. The time of this transfer of q units is $\frac{\pi\,r}{v}$ and had a constant electromotive force E' acted for this time the quantity transferred would have been $\frac{E'\,\pi\,r}{R\,v}$. If this quantity is to equal q, E' must be considered the average electromotive force sought, its value being given by the equation $E' = \frac{2}{\pi}\,H\,d\,v = \frac{2}{\pi}\,E$. Substituting for E its value, $\pi\,Z\frac{n}{60}$, we have, as the average electromotive force generated in one turn of wire on the armature, during one-half revolution the very simple expression $E' = 2\,Z\frac{n}{60}$. Supposing the armature wires to be N in number instead of one, at any moment, therefore, there will



DESIGNING DYNAMOS AND MOTORS.

be but $\frac{N}{2}$ joined in series. We have as the total armature electromotive force $E_a = 2\left(\frac{N}{2}\right)Z\frac{n}{60} = N\,Z\frac{n}{60}$. This value of E_a is given in absolute units; to reduce to practical units or volts, we simply write $E_a\ N\,Z\frac{n}{60}\,10^{-8}$. As showing how the dimensions of the armature affect the result, the equation is often put in the form

$$E_a = 2\,r\,d\,H\,N\frac{n}{60}\,10^{-8}.$$

Now from this last equation it will be seen how simple and accurate is the predetermination of the electromotive force which will be generated in an armature, having upon it any number of wires and revolving at any speed, *having given the intensity of field in which it revolves.*

But perhaps the most difficult problem to be met with in this connection is the forming of some rule by which the intensity of field H may be determined from the constructive data of the machine, such as the amount of wire on the field magnets, their length, weight, etc. And it has only been in the last two or three years since designers of dynamos and motors have taken hold of and utilized the conception of a magnetic circuit and resistance that really practical results have been reached. However, after the work of Drs. Hopkinson, Mr. Kapp and some others, I think it may be said that we have formulæ sufficiently accurate for all practical purposes. Those I shall give are taken mainly from several papers by Mr. Kapp.

It is evident after what has been said concerning the generation of an electromotive force in an armature, that the proper function of the field magnets is to produce lines of force which pass across the armature core, making H as large as possible with the least expenditure of magnetizing power, questions of magnetic moment having no bearing on the subject whatever.

Magnetizing power is measured in ampère-turns, and both experiment and theory show that the effect is the same whether we use many turns of fine wire and a small current or a few turns of stout wire and a large current, so long as the product of ampères and turns remains constant.

Experiment also shows that for low degrees of magnetization the electromotive force produced in the armature is very nearly proportional to the magnetizing power P applied to the field magnets; and as electromotive force and the number of lines of force which pass across the armature core are always proportional, we find in this case Z varies as P.

This relation is otherwise expressed by introducing the conception of magnetic resistance, according to which there is in every magnetic circuit a passive force opposing the creation of lines: the number which are, however, created is the quotient of the magnetizing power and this resistance. Calling the latter R, we have $Z = \frac{P}{R}$.

To illustrate, suppose we have an ordinary two-pole dynamo, as in the accompanying figure, the dotted line representing the magnetic circuit. Now let us denote the average length of the magnetic circuit within the field magnets by L; the cross section of magnets by M; length of armature by b; the arc spanned by either pole by λ: distance between polar surface of magnets and external surface of armature core by δ; also calling l the average length of the magnetic circuit in the armature, which we shall suppose to have a cross section μ. Should the analogy with Ohm's law hold good, that is, if magnetic resistance varies as the length of the circuit and inversely as its cross section, we should expect R to be proportional to $\frac{L}{M}$, $\frac{l}{\mu}$ and $\frac{2\,\delta}{\lambda\,b}$; and in fact Mr. Kapp has found after numerous experiments with machines of this type made of well annealed wrought-iron, that the number of lines which pass through the armature, say up to 60,000 lines per square inch, is represented by the formula

$$Z = \frac{6000\ P}{1440\,\frac{2\,\delta}{\lambda\,b} + \frac{l}{\mu} + \frac{2\,L}{M}}.$$

Also for cast-iron magnets,

$$Z = \frac{0.8\,P \times 6.000}{1{,}800\,\frac{2\,\delta}{\lambda\,b} + \frac{l}{\mu} + \frac{2\,L}{M}}.$$

These formulæ are not, however, absolutely correct, and it is doubtful whether any formula rigorously true for all degrees of magnetization will ever be found, owing to the great difference in chemical composition of different specimens of iron. Nevertheless many electrical engineers of to-day can predetermine the output and efficiency of their machines to within two or three per cent., which is perhaps all that is required in practice.

To take a practical example, suppose it is required to build a dynamo to give a current of 100 ampères at 110 volts pressure and to have an efficiency of 90 per cent. Of the 10 per cent. lost in the machine we will allow 4 per cent. for the field magnets, 3 per cent. to armature and 3 per cent. to eddy currents and friction at bearings. The energy delivered to the external circuit equals $E\,C = 110 \times 100 = 11{,}000$ watts; and denoting total amount of energy delivered to the machine by X we have,

$$\frac{90}{100}\,X = 11{,}000. \quad \therefore\ X = 12222.2 \text{ watts.}$$

Putting y for the magnetizing current of the field magnets we have $E\ y = X \times .04 = 488.8$, whence $y = 4.8$ ampères.

The total armature current $C_a = C + y = 104.8$ ampères.

The total armature electromotive force $E_a = \frac{X}{C_a} +$ counter electromotive force produced by eddy currents in armature core and field magnets. The latter being very small and difficult to estimate, we shall write $E_a = 117 + 3 = 120$ volts. Energy lost in armature equals $C^2\,R = .03 \times X = 366.6$ watts. Therefore $R = .033$ ohm; that is, the resistance of the armature must be .033 ohm. The resistance of the magnetizing coils equals $\frac{E}{y} = 23$ ohms.

Let the type of machine be that shown in section in the diagram, that is, a Gramme ring armature and horseshoe field magnets. Now upon examining the equation, $E = 2\,r\,d\,H\,N\,\frac{n}{60}$, it will be seen that a number of armatures of entirely different proportions may generate the same electromotive force. For instance, one armature may have twice as many windings as another, and will therefore require only half the field intensity or half the speed, or it may have half the diameter, but twice the length; or it may have many other combinations of speed, diameter, length, intensity of field and number of windings, yet still give the same electromotive force; the best dimensions in any case being determined by the limiting conditions. In the present instance let us take the length of the armature as 8 inches and depth radially 2½ inches; then the length of one convolution will be 21 inches. Also let us limit the number of layers on the armature to two. The resistance of the wire on the two halves of the armature is calculated for .033 ohm, and being joined in multiple arc, the resistance of one half of the armature must be .066 ohm. Now suppose we use for the armature a No. 5 (S. W. G.) wire, which has a diameter of 212 inch and a resistance of .0002326 ohm per foot, or .00040705 ohm per convolution. The number of convolutions on one half the armature will be $\frac{.066}{.00040705} = 162$, which also equals the number on the whole first layer. Allowing .015 inch for insulation, the radius r of the armature equals $\frac{162 \times .237}{2\,\pi}$ *minus* the

radius of wire; this gives $r = 6$. Experiment shows a good value for the field intensity H to be about 50,000 lines per square inch, and substituting these values of r, d, N, H and E in the equation for E, we have:

$$120 = \frac{2 \times 6 \times 8 \times 188 \times 50{,}000 \times n}{60 \times 100{,}000{,}000}; \text{ whence } n = 463.$$

That is to say an armature of the above dimensions in a field having an intensity of 50,000 lines per square inch must

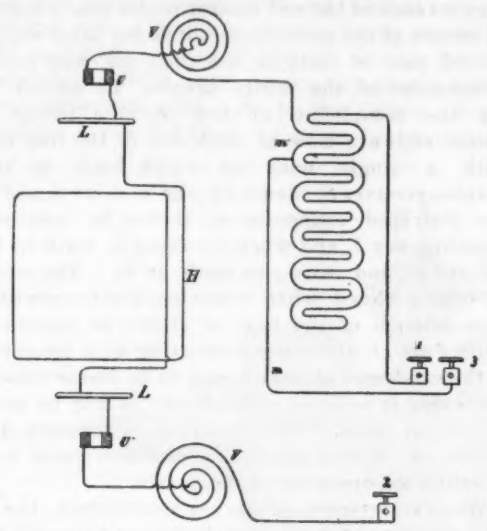


FIG. 6.—DIAGRAM OF WESTON VOLTMETER.

be driven at a speed of 463 revolutions per minute to have generated in it an electromotive force of 120 volts, 110 of which appear at the terminals of the machine, the other 10 being consumed in overcoming the resistance of the armature and by eddy current.

Now we arrive at the second part of the problem, namely, the determination of the number of ampère turns required to produce the intensity of field $H = 50{,}000$. In the formulæ

$$Z = \frac{6{,}000\ P}{1{,}440\ \frac{2}{\lambda}\frac{\delta}{b} + \frac{l}{\mu} + \frac{2\ L}{M}},$$

δ equals the air space plus the thickness of binding wire, plus $2 \times .237 = .7$ inch. Making the arc spanned by either pole .35 of the external surface of the armature, we have $\lambda = 14.2$ inches; also $b = 8$ inches, $l = 14.9$ inches, and $\mu = 20$ square inches. Let the diameter of the magnet cores be 7 inches; then their cross section M will be $\pi \times 7^2 = 155.46$ square inches. Also, if we make the magnet limbs 14 inches long and the yoke 24 inches, then the average value of L will be 66 inches. Substituting in the formula we have

$$2 \times 6 \times 8 \times 50{,}000 = \frac{P}{1{,}440\ \frac{1.4}{(14.2)\ .8} + \frac{14.9}{20} + \frac{132}{155.46}};$$

$P = 15{,}153.8$.

Now as the current through the field magnets is $\frac{110}{23} = 4.8$ ampères, the number of turns on the magnet must be $\frac{15{,}153.8}{4.8} = 3{,}157$; and on each magnet limb $\frac{3{,}157}{2} = 1{,}578$. The average length of one turn may be taken to be $\frac{2\ \pi \times 7.5}{12} = 3.9$ feet; and of the wire on both limbs $3.9 \times 3{,}175 = 12{,}312$ feet; so that the resistance per foot must be $\frac{23}{12{,}312} = .0018$ ohm. Referring to a table of resistances we find No. 15 S. W. G. has the nearest required resistance.

Weston's New Measuring Instruments.

For some time past Mr. Edward Weston has been engaged in the elaboration of a set of electrical measuring apparatus of various kinds, and among them a voltmeter

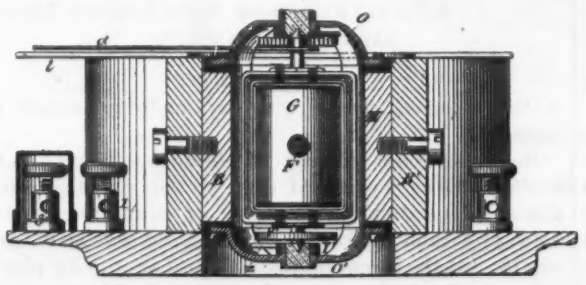


FIG. 2.—WESTON'S NEW VOLTMETER.

occupies a prominent place. The idea embodied in this new instrument is that the current to be measured in circulating through a coil in the circuit, which is supported freely in a uniform magnetic field, shall cause a movement of the coil due to the resultant effect of the current upon the magnetic pole, and to oppose to the motion of the coil a uniform resilient resistance, so that the extent of movement of the coil shall be directly proportional to the strength actuating the current, or, when the current passes through high resistance, to the E. M. F. of the current.

Our illustrations, Figs. 1 and 2, show the voltmeter in plan and section. Fig. 3 shows an enlarged view of the coil and its supports. As will be seen, a circular magnet A' is provided with pole pieces $B\,B'$, which embrace an iron core G, supported by a brass pin F, attached to a bar which spans the pole pieces. The latter are spanned above and below by the bridges $O\,O'$, in which is pivoted the coil H', and are so arranged as to completely embrace the core G, there being only a very small air space between the core G, the coil H and the pole pieces.

This coil H is shown in detail in Fig. 4. It consists of a coil of insulated wire wound on a frame I of copper, and covered on the outside by a smaller frame J, which is thicker than the inner one. Both sides of the coil are then covered with a plate of copper (which is shown broken away at H') in such a manner as to completely cover the insulated wire as with a sheath. The object of this will be well understood; for its effect is to dampen the movement of the instrument and to make it dead beat, as, according to well known law, the currents generated in this sheath by the movement of the coil are such as to oppose the motion of the coil and hence to bring it to rest as soon as the deflection due to the current is reached.

The coil, after being prepared in this manner, is mounted upon the pivots $K\,K'$ fixed to the plates $L\,L'$, which are attached to the coil by an insulating cement.

As above stated, the motion of the coilis opposed by spiral springs; these are shown at $V\,V'$, one encircling the upper and one the lower pivot. The springs are held at their outer ends by arms Z, and are fixed at their inner end to collars encircling the pivots. Fig. 6 is a diagram of the circuits, from which it will be seen that the current enters at the binding post 1, passes through the resistance coil f, to bridge O, arm Z, spring V, ring U, the pin K, plate L, then through the coil H, then out through L', K', the ring U', arm Z', and bridge O', and finally to the binding post 2. As stated above, the scale divisions of the instru-

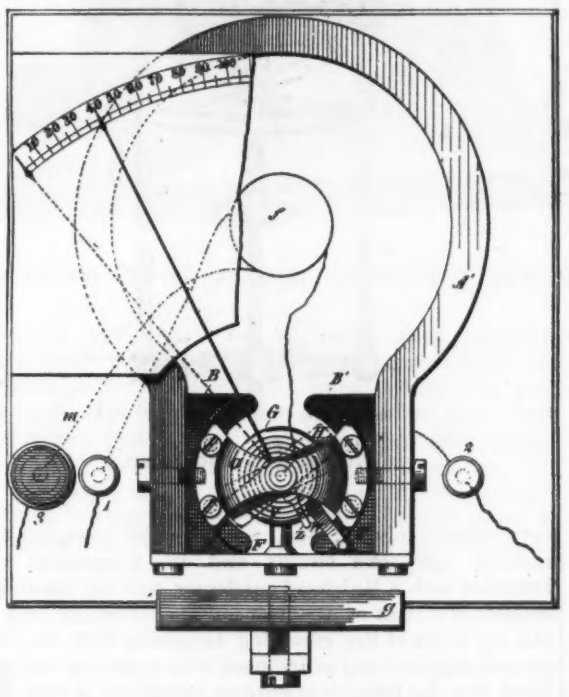


FIG. 1.—WESTON'S NEW VOLTMETER.

ment are equidistant, and they must be so according to the principle upon which the instrument is constructed.

The operation of the instrument is as, follows Fig. 5 showing diagramatically the arrangement of the pole pieces $B\,B'$ and the coil. The whole space occupied by the loop when a current traverses the wire is, of course, like a magnetic shell. If then the coil is placed in proximity to the magnets, it will act when the current is traversing it in the same way as any other magnet, *i. e.*, mutual attraction and repulsion will take place; for if the magnet be fixed and the coil be freely suspended and movable, then the coil will be attracted to or repelled from the magnet poles, as the case may be. Supposing, therefore, that the coil be so adjusted that it occupies the position shown in Fig. 1 and Fig. 5, when no current passes through the coil, then when current is admitted the north pole of the magnet will attract the south side of the coil, and the south pole of the magnet the north side of the coil, and the attraction of the two poles will act as a couple, tending to turn the coil in the direction of the arrow, Fig. 5, until the coil has traveled half its path, or through an angle of 45 degrees. Then the north side of the coil will be opposed to the north pole of the magnet, and the south side of the coil to the south pole of the magnet, and repulsion will follow, which, however, will tend to move the coil still in the same direction, so that the coil will finally assume a position at an angle of 90 degrees from its original position, as indicated by the dotted lines at Fig. 5.

Owing to the fact that the springs which oppose the motion of the coils increase in their resistance to the motion in exactly the same proportion as the motion of the coil takes place, the travel of the pointer is equidistant for equal increments of the current in the coil; hence the only variable factor in the arrangement is the current strength in the coil, the field itself being, of course, constant.

When employed as a voltmeter, the high resistance f is interposed in the circuit of the coil, as shown in Fig. 1, and in the diagram of connections, Fig. 6. There is also provided a third binding post 3, which connects by wire with a definite portion of the resistance coil and by means of which the voltmeter can be calibrated with the assistance of a standard cell of known E. M. F. This binding post 3, when not in use, is covered by a cap, so as to prevent the destruction of the instrument by accidental contact with a circuit of too high a potential. A means of regulation and calibration also is provided in the movable bar of soft iron g, shown in Fig. 1, which is placed opposite the pole pieces and can be moved towards, or from, the same by means of a screw. In this maner the field of force can be weakened or strengthened, and thus the indications of the instrument varied. The range of the instrument can also be varied by varying the amount of resistance in circuit with the coil, and in this way a potential of a fraction of a volt up to 140 volts can be

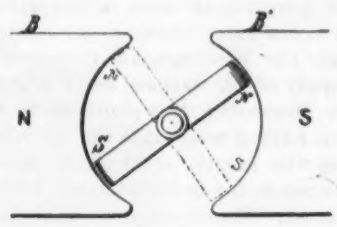


FIG. 5.

measured on the same instrument with the same degree of accuracy. Mr. Weston has also adapted the same form of instrument as an ampére meter, and with equally good results.

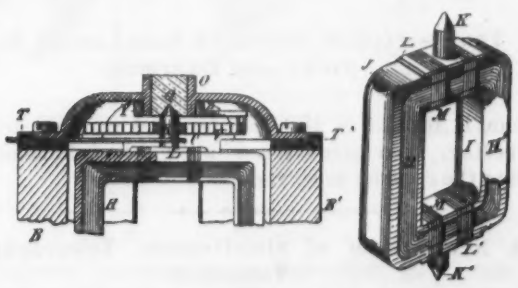
Sale of the Waterhouse System.

We take the following important item from the Pittsburgh *Chronicle*. The news is confirmed by the parties to the sale:

"This paper recently announced the acquirement by Mr. George Westinghouse, Jr., of the entire capital stock of the Waterhouse Electric and Manufacturing Company. The machinery for the manufacture of the arc apparatus of this company is being erected in the works of the Westinghouse Electric Company, and preparations are being made for the manufacture of arc apparatus on an extensive scale.

"When the Westinghouse Electric Company began its operations it had in view confining itself to the alternating incandescent apparatus, and to that end it entered into a contract with the Thomson-Houston Electric Company, of Boston, whereby that company recognized the alternating current patents of the Westinghouse Company, and agreed to sell to the Westinghouse Company its arc light apparatus. The contract existing with the Thomson-Houston Company will, by reason of a notice duly served by the Westinghouse Company, terminate Nov. 30, and the Westinghouse Company is therefore determined to exploit the arc lighting business to the greatest possible extent; and to that end has not only secured the Waterhouse inventions but other valuable inventions relating to the automatic regulation of the current for arc lighting purposes, making the apparatus as manufactured according to these patents superior to anything heretofore offered, not only superior in operation but greatly cheaper in construction.

"It is learned from Mr. Waterhouse, the inventor, who is in Pittsburgh, and has already started one of his arc light dynamos, and is superintending the erection of the apparatus, that there was the keenest kind of competition on the part of the Thomson-Houston people for the acquirement of the controlling interest in the capital stock of the Waterhouse Company, and that the Thomson-Houston Co., after carefully inspecting and testing all the apparatus and investigating all the affairs of the Company, offered to purchase the controlling interest in the stock on more favorable terms; but the Westinghouse Co. had



FIGS. 3 AND 4.—WESTON'S NEW VOLTMETER.

already secured the entire capital stock, and the Thomson-Houston Co. was therefore too late in its operations.

"The Waterhouse Co. has about 5,000 arc lights in operation in a number of small stations.

"The experiments that have been conducted by the Westinghouse Electric Company during the last three months with the Tesla motors have been of a most satisfactory character. A form has been perfected that will operate on the existing alternating circuits for the running of fans and other light machinery, and also the large motors for street car purposes and power purposes generally have been brought to a high degree of perfection and efficiency.

"In street car work the Tesla motor has great advantages over the motors that have heretofore been in use. These motors are usually placed under the car, and are liable to be damaged by water and dust; and, having expensive commutators and brushes; the armatures of the machines are frequently burned out, making the expense of maintenance excessive. The Tesla motors, having no brushes or commutators, can be constructed so that even if covered with mud and water no possible danger can occur.

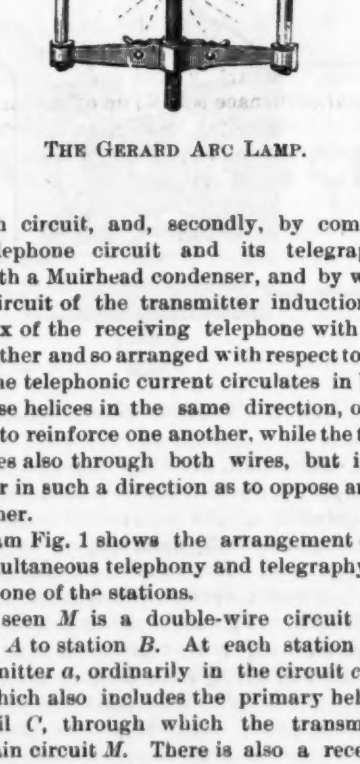
"The manufacture of the Shallenberger meter for measuring the supply of light is being pushed. Already 100 meters per week are being turned out, and the required machinery for 300 per week is being obtained, while the demand for meters is greatly in excess of the present supply. These meters will measure the currents for the motors and for lighting, and will give to all users of the light the advantage of the electric light and motors for power purposes at rates in competition with gas for light and at low rates for the motor service.

"Already the Westinghouse Company has contracted for the supply of 122 stations, 38 of which have ordered machinery, increasing their plants since starting, some of the stations having been made successively for increases.

"During the month of October the apparatus contracted for amounted to 48,000 lights, 25,000 of which are for use abroad. The increase in business has obliged some of the departments of the company to be run until 10 o'clock at night."

The Gerard Arc Lamp.*

The accompanying engraving illustrates one of the latest forms of arc lamps devised by M. Anatole Gérard. The most striking part of the mechanism is the brake, which consists of two arms crossed in the shape of an X, and carrying two steel gudgeons, which press against the upper carbon-holder. These arms are connected by two small cranks to a cross piece placed underneath a double solenoid, joined in parallel with the main circuit. The soft iron cores of the solenoids rest on this cross piece, their other ends being attached to two strong springs. When the circuit is closed the carbons are apart, and the whole of the current passes through the shunt; the solenoids attract the armatures, lowering the X-shaped brake, which presses its arms upon the plate beneath, and unlocks the upper carbon holder; the latter consequently descends and brings the two rods into contact. But at this moment the current in the shunt decreases, the springs act upon the cores, lifting them up, and causing the brake to clutch the upper carbon-holder, and lift it also; the carbons are thus separated, and the arc is struck. When the consumption of the carbons causes the arc to lengthen unduly, the current in the shunt again predominates, and allows the upper carbon to feed down slightly. The central tube is an air tight cylinder, the piston of which forms part of the upper carbon-holder. When the carbon-holder descends, a partial vacuum is formed in the cylinder, and prevents irregular feeding. An external screw allows the admission of air into the cylinder to be regulated to a nicety.



THE GERARD ARC LAMP.

A New System of Simultaneous Telegraphy and Telephony.

Among the various methods proposed for sending simultaneous telegraph and telephone messages over the same wire is a system consisting of metallic circuits coupled together at the ends so as to form a third metallic circuit of which the first and second circuits constitute, respectively, the two sides. Referring to this system, Dr. W. W. Jacques in a patent recently issued points out that it is difficult to so balance the circuits that there shall be no interference between the two classes of transmission. In order to obviate this difficulty Dr. Jacques has devised a system which comprises the use of a metallic or double-wire main circuit, the two wires of which constitute the direct and return wires for the telephonic utilization, and an earth branch at both ends, with which the telegraph sending and receiving instruments are connected. The telephonic organization thus as a whole comprehends receiving and transmitting instruments at each station included in the metallic circuit, while the telegraphic organization as a whole includes the two wires of the metallic circuit, the attached earth branch at both ends, and the telegraphic instruments included in the earth branches.

Interference between the two kinds of transmission is prevented, first, by including a Muirhead condenser in the earth-branch circuit, and, secondly, by combining the metallic telephone circuit and its telegraphic earth branches with a Muirhead condenser, and by winding the secondary circuit of the transmitter induction coil and also the helix of the receiving telephone with two wires twisted together and so arranged with respect to the circuit wires that the telephonic current circulates in both of the wires of these helices in the same direction, or in such a direction as to reinforce one another, while the telegraphic current passes also through both wires, but in opposite directions, or in such a direction as to oppose and neutralize one another.

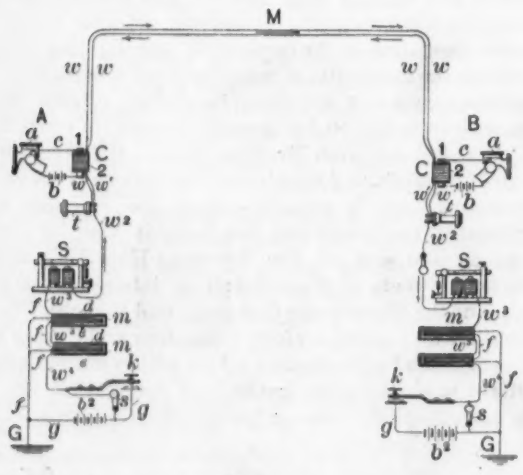


FIG. 1.—JACQUES' SYSTEM OF SIMULTANEOUS TELEGRAPHY AND TELEPHONY.

The diagram Fig. 1 shows the arrangement of two stations for simultaneous telephony and telegraphy, and Fig. 2 a detail of one of the stations.

As will be seen M is a double-wire circuit extending from station A to station B. At each station is a telephone transmitter a, ordinarily in the circuit c of a local battery b, which also includes the primary helix 1 of an induction-coil C, through which the transmitter acts upon the main circuit M. There is also a receiving telephone t, and these are all that is necessary for the telephonic operation of the line.

As more clearly indicated in Fig. 2, the secondary helix 2 of the induction coil C and the helix n of the receiving telephone t are both wound with two wires twisted together. It will be understood that by means of this induction coil the variations of current produced by the operation of the transmitter are induced upon the metallic circuit, of which both of the wires of the secondary helix form a part, and that by means of the receiver the telephonic currents passing in the metallic circuit reproduce the vocal sounds. The telephonic currents traversing the metallic circuits and acting upon the telephone receiver are indicated by the short arrows, and at any given moment are necessarily traveling in opposite directions in the two wires. The two wires w are, however, so connected with the two wires of the induction coil and receiver helices that the current in both wires is in the same direction, as may be readily seen by tracing the wires in the detail diagram, and as a necessary consequence they reinforce one another; so that if at any given moment the current in one of the wires is of a direction to increase the magnetism of the cores the current in the other wire also has the same tendency, and vice versa. The metallic circuit is thus electrically responsive in the highest degree to changes caused by the transmitter, and in like manner the telephone receiver is sensitively responsive to telephonic variations occurring in the metallic circuit.

We now pass on to the description of the telephonic annex to such a metallic circuit, whereby simultaneous telegraphy is made commercially practical. As before stated, the helices 2 and n are each wound with two wires. Two of the ends are of course connected, as shown, with the two entering ends of the metallic circuit. The remaining two ends of the coil nearest to the line constitute the extension of the metallic circuit to the other coil, and the second pair of ends of the final coil may prior to the attachment of the earth branch be united together for the completion of the metallic circuit. These united ends are now at each end of the line connected with a single wire w^2 which leads to the telegraphic receiver S, thence by the wire w^3 to and through the Muirhead condenser m, thence by wire w^4 to the signaling-key k, and when receiving to earth by switch s, battery b^2, and wire g to earth at G. The switch s is of course closed when receiving and is open during the manipulation of the key, as shown at station A. The wires f are ground-wires connecting with the earth plates of the condenser m, which may be in two or more sections connected in series or multiple arc, as may be required in individual cases. The receiving instrument S and the condenser m may exchange places without materially affecting the operation of the system.

When telegraphic signals are transmitted, the current of the battery b^2 flows over the line and through the condenser, also through the telephone receiver and induction coil helices, and then over the two wires of the metallic circuit, which, however, as already stated, furnish but one line of conduction. This current is indicated in the drawings by the single long arrows. In passing round the cores of the telephone instruments, in virtue of the peculiar mode of connection, it traverses the two wires in opposite directions or differentially, its magnetizing effect being thereby nullified, the effect of a portion of the current in one of the wires being neutralized by the effect of an equal portion of the same current oppositely exerted in the other. This neutralizing effect is aided and intensified by the fact that, as above described, the two wires of both coils are twisted together, and thus further equalized. The telegraphic currents have, therefore, no effect upon the telephone instruments in the metallic circuit at either station, but act upon the telegraphic receiver in the distant earth branch, causing the messages to be reproduced thereupon. By interposing switches s^2 in the respective telegraph branches these may, of course, be be discontinued whenever desired. The key controlling switches s may, if necessary, be so connected as to cut off the battery b^2 when closed, as at station B or as at station A the receiving circuit may be made to include the battery b^2.

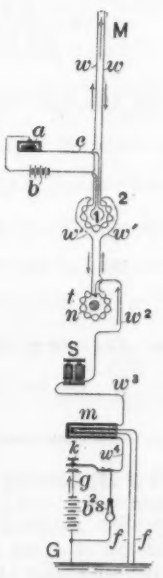


FIG. 2.—JACQUES' SYSTEM OF SIMULTANEOUS TELEGRAPHY AND TELEPHONY.

The telegraphic battery b^2 is shown as being divided, half of it being located at each station, and a condenser also at each station. This mode of connection is sometimes preferable, especially if the main line be of great length; but the inventor obtained good results by placing the entire battery at one of the terminal stations, and when this is done it is only necessary to provide a condenser at the battery end of the line.

It may be remarked that the Muirhead condenser referred to above is of the same type as that employed for the purpose of duplexing submarine cables, and which is also a resistance, and which, with a considerable capacity, furnishes, also, a continuous and unbroken line of conduction, the resistance and capacity being uniformly distributed with respect to one another.

In a line fitted with these appliances, and constituted of about three hundred miles of double wire, Dr. Jacques has obtained good results by using a condenser having a resistance of 600 ohms and an electro-static capacity of about 8 microfarads.

* From M. Hippolyte Fontaine's "Eclairage à l'Electricité."—*London Electrician.*

The Heroult Aluminum Process.

We had recently an opportunity, says *Industries*, of inspecting the works of the Swiss Metallurgical Company, established close to the Rhine Fall at Neuhausen, on the right bank of the river. The production of aluminum, and especially of aluminum alloys, by electrical means, forms one of the most important branches of the company's business, and after experimenting with Dr. Kleiner's method of producing pure aluminum it was finally decided to adopt the method devised by M. Heroult for the production of aluminum alloys, and a large plant on this system is now successfully at work. As in the Cowles process, the aluminum is reduced from its oxide by means of a very strong electric current, but the action of the current is different in the two systems. In the electric furnace devised by the Cowles brothers the current is simply and solely used to produce an excessively high temperature in a limited zone, and the reduction of the ore is due to the high temperature alone and is in no way an electrolytic process. The Cowles furnace can therefore be worked with an alternating current, but this is not the case in the Heroult process. According to the views held by the inventor of the latter process, the reduction of the ore is due partly to the heat of the voltaic arc and partly to an electrolytic action of the current.

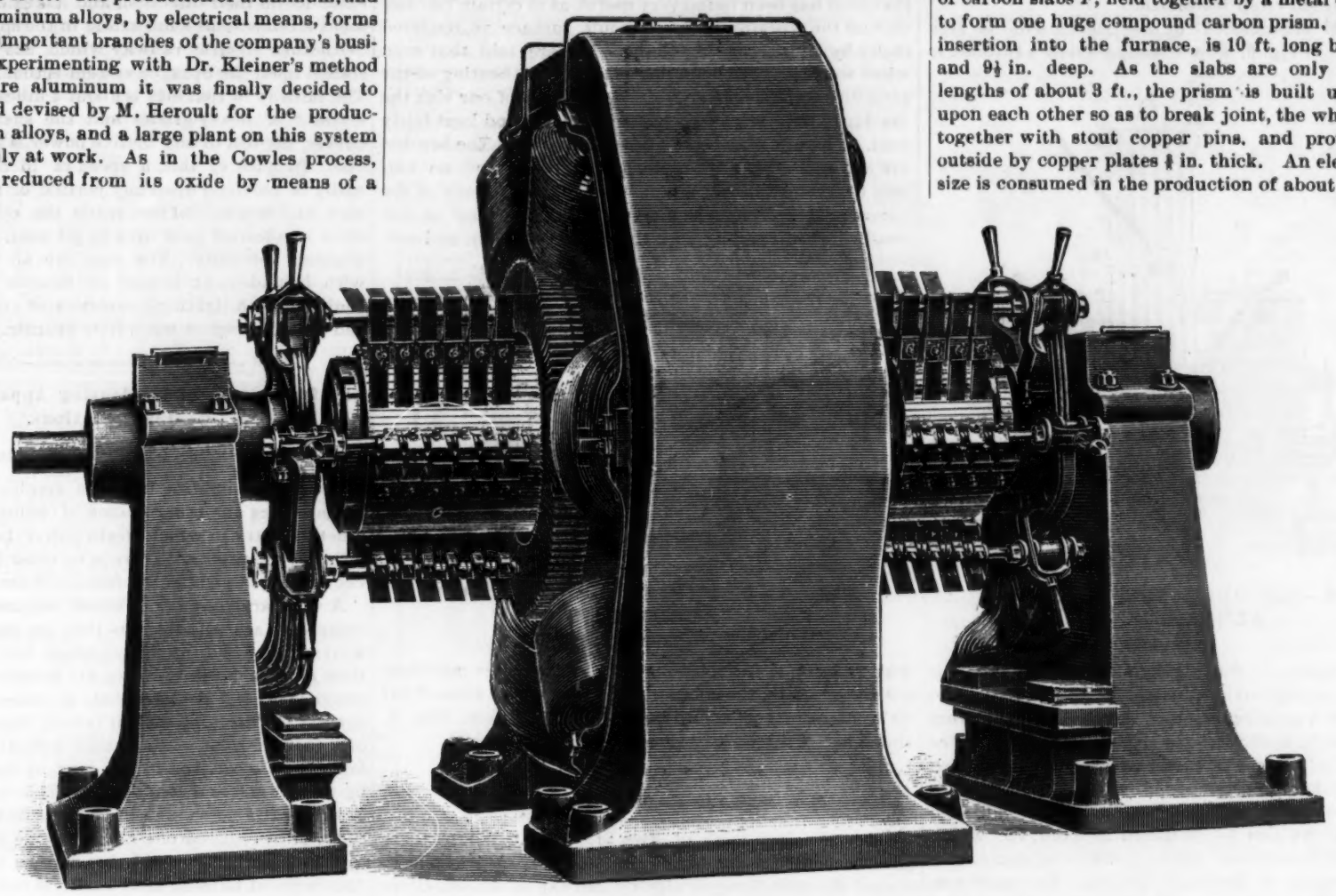
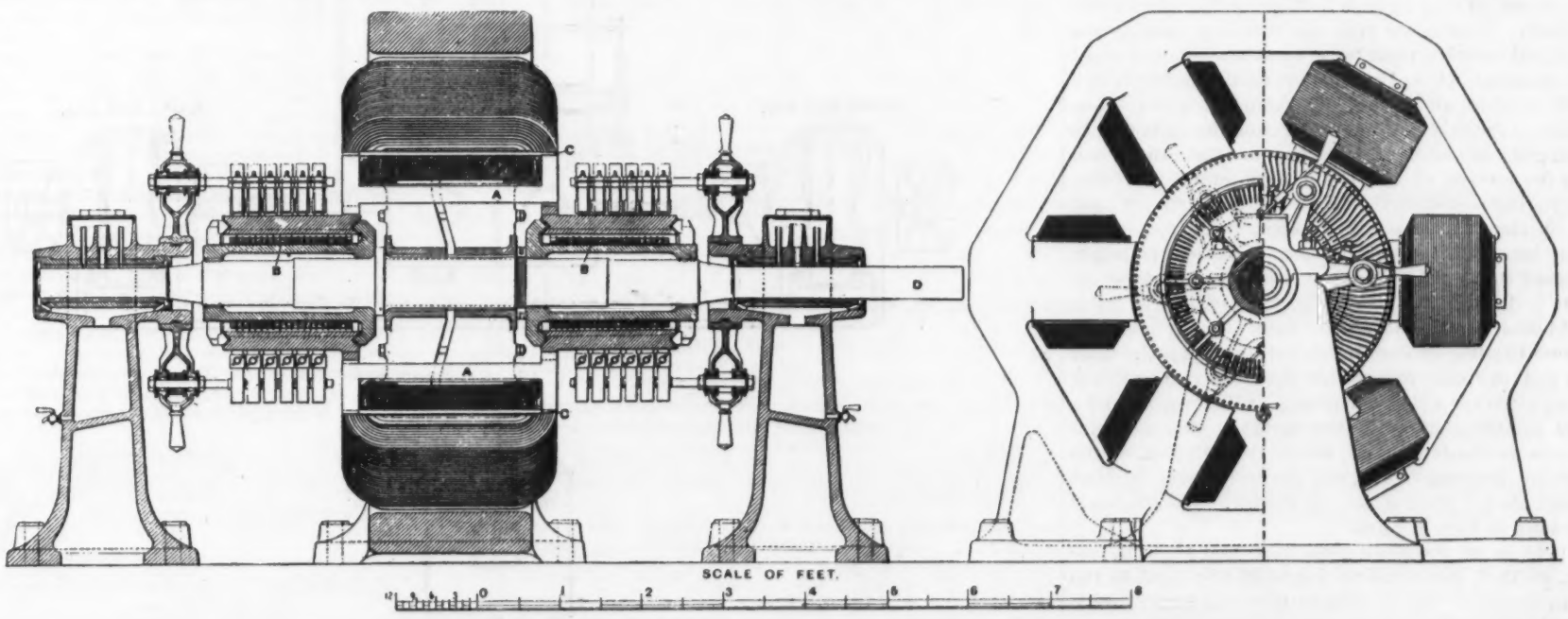


FIG. 1.—BROWN'S DYNAMO FOR SMELTING ALUMINUM.

In the Heroult furnace the melted mass of oxide takes the place of the electrolytic in an ordinary voltaic couple, the reduced metal at the bottom of the furnace being one electrolytic and a carbon bar inserted from the top of the other. Upon a current passing from the carbon bar through the ore to the metal the ore is decomposed, oxygen traveling upwards and attacking the carbon, whilst the molecules of the reduced metal travel downwards, and are merged in the metal bath.

The construction of the furnace will be understood from Figs. 4 and 5, the former being a sectional elevation and the latter a plan. The body of the furnace, or to speak more correctly, of the electric crucible, consists of a block of carbon *B* contained in an iron box *A*. In the first crucible made, the iron box was cast round the carbon block in order to obtain a very intimate contact between the surfaces, and thus facilitate the conduction of electricity from the electrodes *C* to the interior. The iron, by contraction upon cooling, would securely grip the surface of the box from all sides, thus insuring perfect contact. This method of construction is, however, only suitable for small crucibles, and the present large furnace is built up of carbon slabs held together by a wrought-iron casing, no difficulty having been experienced in making good contact between the two materials. At the bottom of the cavity in the carbon block is a tap hole *D*, closed by a plug *E*, which is withdrawn from time to time to allow the liquid alloy to run into the ladle *L*, from whence it is cast into ingots. The current enters the crucible by the upper carbon electrode, consisting of a bundle of carbon slabs *F* suspended by a chain. The chain passes overhead round the drum of a small winch, which is controlled by the attendant, and as the lower end of the electrode is being consumed, the latter is allowed to descend so as to keep the distance between the surface of the molten liquid in the crucible and the end of the carbon electrode as near as possible constant. We may here remark that this distance is preferably made very small, and should in practice not exceed 3 millimetres.

The inventor lays particular stress upon the necessity of keeping the distance between the electrodes small. The intervening space, being filled with a layer of badly conducting molten ore, offers a resistance which increases with the distance; and although resistance is necessary in order that the current should produce heat, it is not economical to have more heat than is just sufficient to melt the ore, the work of separating the metal from the oxygen being chiefly done by the electrolytic action of the current, and not by high temperature. The electrode consists of carbon slabs *F*, held together by a metal clamp *G*, so as to form one huge compound carbon prism, which, before insertion into the furnace, is 10 ft. long by 17 in. wide and 9½ in. deep. As the slabs are only obtainable in lengths of about 3 ft., the prism is built up of slabs laid upon each other so as to break joint, the whole being held together with stout copper pins, and protected on the outside by copper plates ⅛ in. thick. An electrode of that size is consumed in the production of about half a ton of contained aluminum. The crucible is closed by a cover *H*, also made of carbon slabs, but insulated from the body of the crucible. Holes *J* are provided in this cover through which the ore and scrap metal are introduced, and these openings can be closed by shutters *K*. The ore used is alumina free from silicon and other impurities, and the scrap metal is either iron or copper, according as the desired product is a ferro or a bronze. Bauxite could be used instead of alumina; but as the former mineral contains many impurities, M. Heroult prefers the absolutely pure though more expensive alumina. The cost of the raw materials is, however, in either case not a very important item as compared with the cost of power, carbons, and depreciation of plant. The process of smelting is a continuous one, and need only be interrupted when the upper electrode has been consumed, and then only for the short time required to insert a new electrode. The crucible is periodically charged through charging holes, and the molten alloy is tapped off at *D* from time to time. The production of aluminum per horse-power hour varies somewhat with the percentage of the metal contained in the alloy, the average being 30 grammes of contained aluminum per horse-power hour, and the maximum 40 grammes. Reduced to English measure this works out to an expenditure of 15 horse-power hours per pound of contained aluminum under



FIGS. 2 AND 3.—BROWN'S DYNAMO FOR SMELTING ALUMINUM.

average, and 11 horse-power hours under very favorable conditions. The present production of the crucible is 4 cwt. of contained aluminum in twenty-four hours. The crucible can also be used for the production of silicon bronze, in which case the scrap copper is charged not with alumina, but clean white sand.

The general arrangement of the works will be seen from the plan in Fig. 6. Power is supplied by a turbine, to

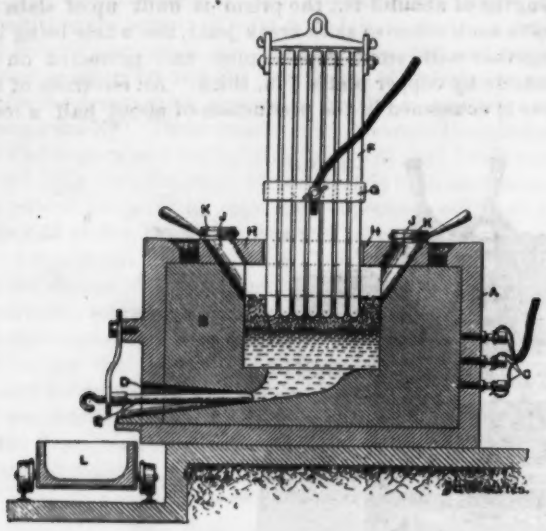


FIG. 4.—CRUCIBLE FOR SMELTING ALUMINUM.

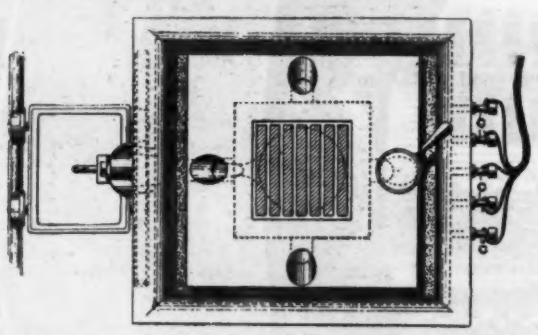


FIG. 5.—CRUCIBLE FOR SMELTING ALUMINUM.

the shaft of which are directly coupled the two dynamos supplying the current to the crucible. These large dynamos are excited by a smaller machine driven by a belt from the turbine shaft, as shown; and the speed of the turbine and strength of the main current are controlled by an automatic regulator acting upon a throttle valve placed in the inlet pipe of the turbine. Within certain limits the main current can also be regulated by hand, for which purpose one of Brown's electrical regulators is inserted into the exciting circuit of the small dynamo. The main conductors are naked copper cables or bars, and no special precautions are employed to insulate them, as in comparison with the huge working current a leakage of 100 ampères, more or less, is too insignificant a matter to trouble about. The current is measured by a large ampère-meter indicated by a circle in our illustration. The main current passes once through this circle, in the centre of which is pivoted an electro-magnet, provided with a pointer and counter-weight. The electro-magnet is excited from a primary battery, giving a constant E. F. M., and the calibration of the instrument can be varied by fixing the counter-weight further from or nearer to the centre of suspension of the magnet, so as to obtain a fairly large deflection for the usual working current. During our visit the working current was about 12,000 ampères; but on several occasions a short circuit occurred, when the current would suddenly rise to 20,000 ampères and more. The short circuits are generally due to the fact that one or other of the carbon slabs composing the electrode projects beyond the others, and touches the surface of the metal bath in the crucible. The projecting portion is then immediately burnt off; but during the time that this takes places, the current is considerably increased beyond its normal value. It might be supposed that a short circuit of such magnitude would be likely to damage the electric machinery, but so far as we could ascertain this is not the case. The dynamos do not appear to suffer in the slightest degree from the short circuit, and the only indications that the visitor has of its taking place are a slight sparking at the brushes and a peculiar rumbling noise in the turbine. The dynamos were made to the designs of Mr. C. E. L. Brown, by the Oerlikon Engineering Works, and the turbine was supplied by Messrs. Escher Wyss & Co., of Zurich. We illustrate the dynamos in Figs. 1, 2 and 3.

The field is of the multipolar type and made in one casting, so that there are no joints of any kind in the magnetic circuits. The armature is of the usual Brown type, with embedded wires, but contains two distinct circuits, each provided with its own commutator. The armature is 38 in. diam. and 24 in. long. The conductor consists on the outside of round copper bars *C*, ⅝ in. diam., and on the inside of flat copper plates *A* placed into grooves planed out of a wood lining, by which these plates are firmly held and at the same time insulated. The current is taken off each commutator by six sets of brushes, there being in all seventy-two brushes on each machine. Although cross connections between equipotential coils on the armature are not absolutely necessary when the number of brushes employed equals the number of field poles, the designer of the machine has thought such connections nevertheless advisable as tending to fairly distribute the work between all the armature wires; and equipotential sections of the commutator have therefore been connected by means of rings *B*. Each of these rings is provided with three projections containing grooves into which dovetail the corresponding commutator sections. As it was impossible to apply solder to make the joints, the surfaces have been silvered and made a tight fit. The machines were originally intended to give each a current of 6,000 ampères at 20 volts pressure when running at 180 revolutions per minute; but in designing them Mr. Brown allowed a sufficient margin in the strength of the field to be able to work at 30 volts. This provision has been found very useful, as in certain circumstances the working of the Heroult furnace is rendered easier by an increase of voltage. We are told that even when working at 35 volts there is no undue heating of the armature core from hysteresis. At the time of our visit the machines were working at about 20 volts, and kept fairly cool. There is no fan provided for cooling. The brushes are not separately adjustable, and the lead from no current to full load is only ⅛ inch on the circumference of the commutator. There is absolutely no sparking at the brushes when running with the normal current, and notwithstanding the necessarily rough usage these machines are subjected to, the commutators were at the time of our visit in excellent condition. Our illustration, Fig. 1, shows a general view of this remarkable machine.

New Sprague Road at Akron, Ohio.

Since the last issue of THE ELECTRICAL WORLD there have been a large number of street railway men who have visited the new Sprague electric railway at Akron, Ohio, for the purpose of investigating its operation. There are now five new cars in operation in that city and the sixth will be put into service shortly. The road is quite hilly, with hardly any distance of level track. In spite of this and the muddy streets, the cars make from 12 to 13 miles an hour with ease, and give great satisfaction to the officials and general public. The visitors to this road have included representative street railway men from nearly every section of Ohio, Indiana and Illinois. They have given the system a careful and searching investigation, the management affording them every possible opportunity for doing so, and the universal verdict has been that the Sprague system is all that is claimed for it.

Some of the visitors expressed recently the desire to see the method of using the motors for braking the cars, by reversing them when under full headway. Some experiments were tried with this end in view, giving perfectly satisfactory results. One car running at the rate of 12 miles an hour upon an down grade was stopped within a distance of 3 feet, showing that in case of danger this method of braking is much more effectual than even the best system of railroad air-brakes. The electric road has been such a great success, that the management have received a large number of petitions from residents in different portions of Akron, requesting that the road be extended in their direction, and it is said that the management intends some such action in the spring.

Another electric railway which has recently been installed upon the Sprague system is that at Lafayette, Ind. The railway in that city is about 4 miles in extent, and on account of heavy grades and the sharp and numerous curves, the test of any motive power is a peculiarly severe one. In spite of this, a speed of 15 miles an hour can easily be obtained upon any portion of the road, if necessary, and in a special test made the other day one motor drew two loaded cars up a 10 per cent. grade without the slightest difficulty. The cars are all brilliantly lighted with incandescent lamps, in flexible sockets, and are equipped with lightning arresters of the Sprague patent, and patent noiseless wood fibre gearing.

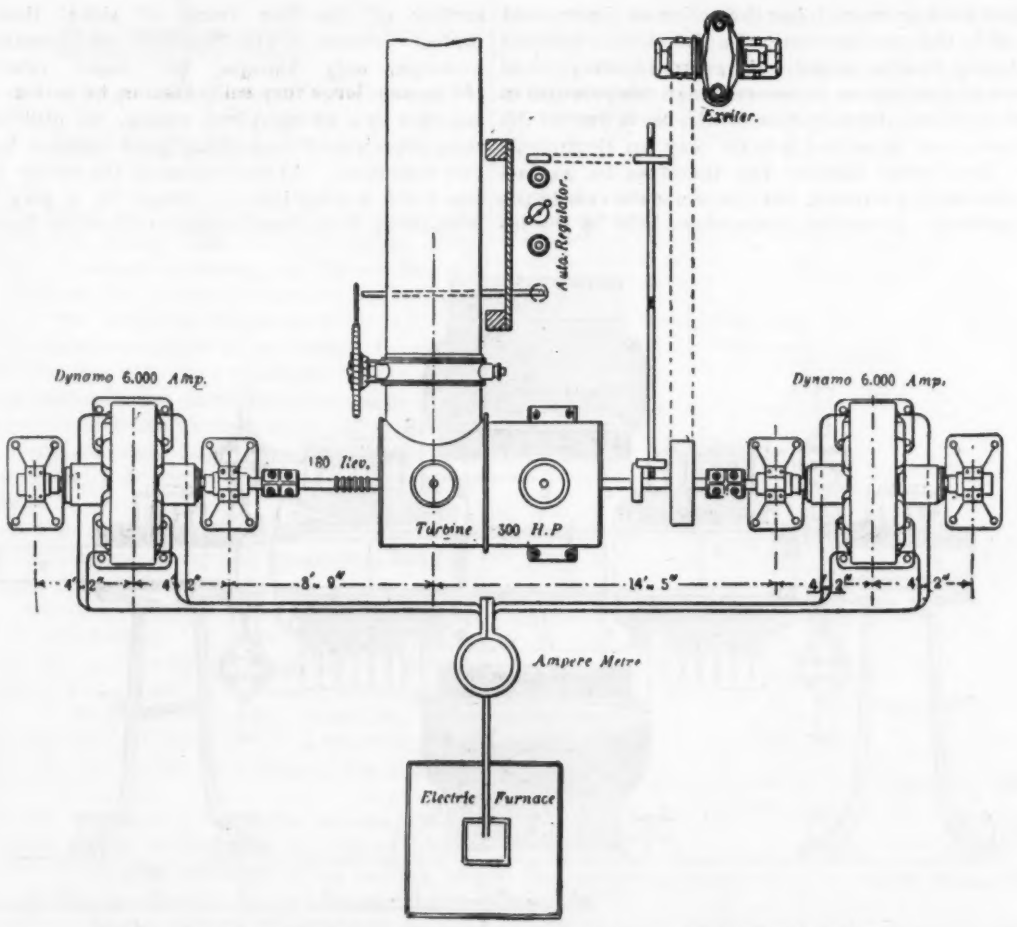


FIG. 6.—GENERAL ARRANGEMENT OF SMELTING PLANT.

The Importance of Condensing Apparatus in Electric Light Stations.

BY LOUIS R. ALBERGER.

The electric lighting interests employ more high class engines than any other branch of industry. There is no other industry in which steam power bears so close a relation to the profits. There is no other industry in which condensing apparatus is a feature of such first importance.

A very large number of steam engines used by electric companies are situated so that an adequate supply of water can be had for condensation, but are at the present time non-condensing. They are laboring under the back pressure of 14.7 pounds that is caused by exhausting against the atmosphere. It is well known that the value of a vacuum to an engine under normal conditions is at a low estimate equal to 20 per cent. of the power developed by the engine non-condensing. This means that by the use of a suitable condensing apparatus the coal consumption can be reduced one-fifth with the same production of light; or the number of lights may be increased nearly a fifth without burning more fuel. It is hardly necessary to intimate that this result would be acceptable to any electric lighting company, and that this matter of condensers for steam engines should have more serious attention than it has yet received.

In cotton mills the steam plants are carefully arranged, and have the attention that is necessary to insure economy, and condensing engines are quite generally used; but the money paid for coal is of small importance when compared with the value of the cotton manipulated by the company. Flour mills are also large users of power, and every effort is made to have the fuel bill as small as possible, but still the much greater cost of the wheat bought places the coal bill in a secondary position. With electric light and power companies, however, the thing is different. By the combustion of coal a latent energy is aroused, which, through the agency of steam and the steam engine, becomes motive power. The function of the dynamo is to change this power into its equivalent electricity, and electricity in turn produces heat, and lastly light is the goods that the company offers

for sale. The cost of the light is dependent primarily upon the cost of the coal. Any increased economy of the boilers or engines, improved belt transmission or dynamo efficiency directly affects the profits.

If a miller could have one-fifth of his wheat flow into his bins, without cost to himself, he would surely consider it of great value. In precisely this aspect the manufacturer of power and light should look upon the condenser as a means to very greatly increase the efficiency

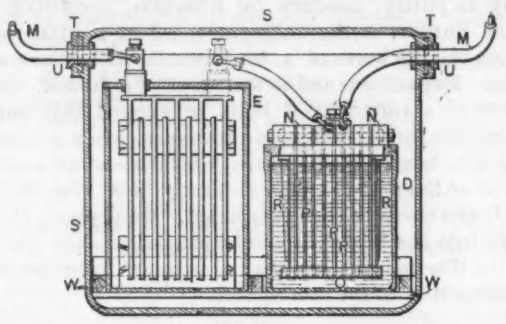


FIG. 1.—LOWRIE-HALL ALTERNATING CURRENT METER.

of his steam plant. It might be added that when engines are changed from non-condensing to condensing it has often been found possible to lower the boiler pressure 10 to 20 pounds, with nearly as good results. Doing this often lengthens the life of the boilers considerably, and is very desirable to such as have had long service.

On the Measurement of Electricity in a House to House Supply.*

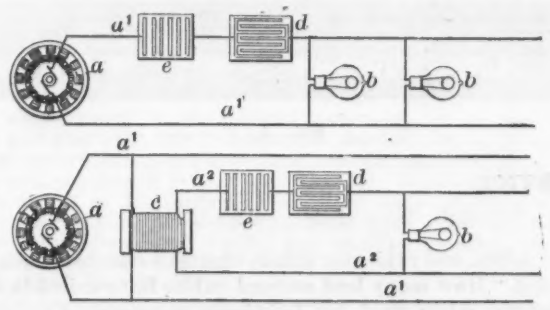
BY W. LOWRIE.

This new system is based on the differentiation of the main or alternating electromotive force, which effect can be brought about in many ways. The one used now by Messrs. Lowrie & Hall, in their house-to-house lighting system at Eastbourne, depends upon the introduction of a constant electromotive force into the main or alternating circuit, which, while it reinforces the main electromotive force in the half alternation in a direction positive to it, retards it in that direction which is negative to it; so producing a subsidiary or resultant extra current to the main or alternation current in that half alternation which is positive to the constant electromotive force.

This subsidiary current must be necessarily exactly proportional to the main current, or what is the same thing, to the resistance of those appliances in which the electrical energy is expended. Thus, by putting a deposition cell in series with the source of the constant electromotive force, the amount of deposit will become available as a current measure. So that the fact of the current being an alternating one allows the use of a deposition cell (when the addition of a constant electromotive force has been made); for where, as before pointed out, with a continuous current the passage of copper would be excessively large, by the application of this invention to an alternating current, this passage may be reduced to a minimum, so long as it remains sufficient for a practical measurement, for this passage depends alone on the magnitude of the subsidiary electromotive force.

Having now described their method of obtaining an alternating current in which the maximum current in one-half of an alternation is greater than that in the other half in the opposite direction, we will proceed to describe the practical method of obtaining from it the efficient method of meterage at present adopted by Messrs. Lowrie & Hall, and to give a detailed description of the appliances and also the methods of obtaining constants.

The meter illustrated in Fig. 1 is of the same type as that at present in use and manufactured by the inventors. The main *M M* is severed as it proceeds directly from the dynamo, converter, or other source of electrical energy to the lamps or other appliances in which the energy is expended, and the meter put across the break, so that the entire current, which has to be metered, passes directly through it. The current on entering the meter passes through the secondary cell *E*, whose electromotive force equals 2 volts, so producing the necessary differentiation in the positive and negative directions in half of an alter-



FIGS. 2 AND 3.

nation. That is to say, that supposing the electromotive force of the dynamo or converter to be 100 volts and the main current to be 10 ampères. Then in the half alternation positive to the constant cell at its maximum point :

Total electromotive force = 202 volts.

$\therefore$ The maximum current $= \frac{202}{10} = 20.2$ ampères.

While in the other half alternation:

Total resultant electromotive force = 198 volts.

The current $= \frac{198}{10} = 19.8$ ampères;

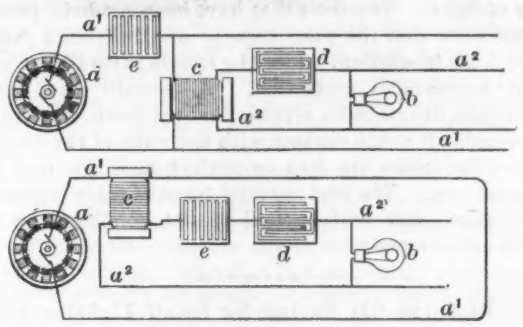
so giving an effective current of .4 ampère.

But this current lasts for only one-half of an alternation, in the same way that an alternating current does in consequence of its necessary fall from its maximum positive point to a neutral point, in order to rise to its maximum negative point; so that, although at its maximum point, the effective current = .4 ampère, yet its average current is only .2 ampère for all the time. Or, which is the same thing, a current due to 2 volts only. So, it is evident that the resultant current may be considered as one merely resulting from 2 volts constantly acting through the circuit resistance.

The application of this effective current takes place in the depositing cell *D*, which is a cell in which the electrodes are of copper, alternately connected together; and the solution a slightly acidulated saturated solution of recrystallized sulphate of copper in distilled water.

One size of the meter is designed for a 20 16 c. p. 100-volt lamp installation, or for a maximum current of 12 ampères; the area of the plates is 48 square inches, giving an area of 4 square inches per ampère, which, with the strong solution used, gives a resistance quite negligible. The capacity of the secondary cell is to register 400 units without recharging. The engraving, Fig. 1, shows the details of a 40-light meter. The depositing cell is composed of an alloy unacted upon by the solution: the plates *P P*, are kept at equal distances by the distance pieces *N N*; by which, also, the connections are made between the alternate plates *P P*, a like connection being made by similar distance pieces, which are not shown in the drawing, between the other alternate plates. They are also kept at equal distances by the slots in the vulcanite pieces *Q Q*, supported by the metal bridges *R R*; the exterior sides of the plates being coated with an insulating enamel, so that no deposition can take place upon them.

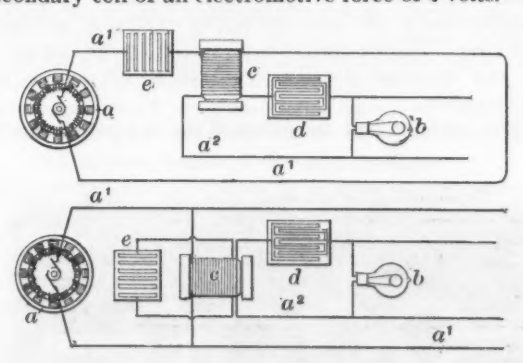
By an examination the very simple method of removing the plates for weighing purposes, etc., without danger of



FIGS. 4 AND 5.

injuring the deposit, will be seen; their removal being effected by releasing the nuts at the ends of the distance pieces, and the plates slid out. The whole is contained in the cast-iron case *S*, with the cover screwed down by the screws *T T*, the cables entering through the insulating washers *U U*, the insulation of the secondary cell from the containing case being effected by the insulating frame *W W*.

To obtain the constants in the constant electromotive force and depositing cell systems, take, for example, an electric lighting circuit, with an electromotive force of 100 volts, and for a constant source of electromotive force a secondary cell of an electromotive force of 2 volts.



FIGS. 6 AND 7.

Then within an alternation in a positive direction to the cell—

Total E. M. F. = 102 volts.

And in a negative direction—

Resultant E. M. F. = 98 volts;

so giving a difference of potential of 4 volts for half the time of an alternation, as before explained.

Therefore, in so far as the chemical action is concerned, the electromotive force of the cell, *i. e.*, 2 volts, may be considered as working constantly through the resistance of the lamps.

From this the constants of grammes per unit or units per gramme are easily arrived at. Thus—

In a 100-volt circuit with 10 ampères flowing

Work = 1,000 watts.

And since

Resistance of exterior circuit = 10 ohms.

$\therefore$ The subsidiary current from the scondary cell $\frac{2}{10} =$ ·2 amp.

$\therefore$ The effective quantity of electricity passing through the electrolyte, with 1,000 watts in exterior circuit, for 1 hour (*i. e.*, 1 unit) = .2 × 3,600 = 720 coulombs.

$\therefore$ The constant for a copper deposition meter is, during 1 unit of exterior work, 720 × .000327 = .23544 grammes of copper are deposited.

The requisite capacity of the secondary cell is only one-half that of the capacity calculated from the number of ampère hours required to deposit the copper.

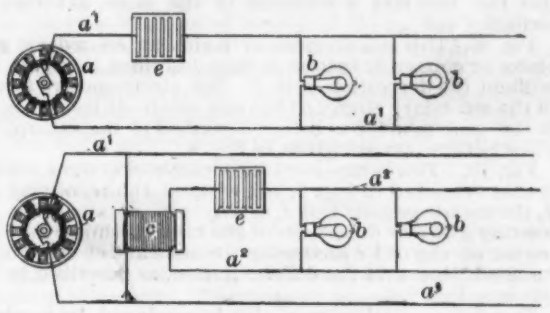
The discharging current, when the current is positive to the cell, is that resulting from 4 volts, for half an alternation, more than 98 volts (*i. e.*, 2 volts from the cell + 2 volts from the dynamo); and on the negative alternation the cell is charged resulting from an E. M. F. of 98 volts. Thus the charge of the dynamo neutralizes the discharge, so leaving a 2-volts discharge for only one-half the time.

Given pure copper sulphate and distilled water, and good copper, it is obvious that the meter must be absolutely accurate. But in consequence of slight impurities, which must necessarily occur, an error, certainly of not more than 2 per cent., may be deducted, so giving an accuracy, under certain conditions, of at least 98 per cent.

The use of copper in the depositing cells is quite optional, as any metal and solution may be used, by which any practical electro-deposition may be obtained; copper, however, is considered, at present, by the inventors to be the most convenient and cheapest electrode.

Various forms of self reading or self recording depositing cells are made, the usual form being a dial pattern, the needle of which is actuated by the alterations of the weights of the electrodes.

Another form is that of a gas meter in which the electrolyte is decomposed by the passage of the subsidiary current, a graduated gauge-glass enabling a consumer to



FIGS. 8 AND 9.

see approximately what his consumption may have been.

In the following and other diagrams which will be described, *a* indicates the generator; a^1 the main circuit; a^2 the secondary circuit; *b* the lamps or other appliances in which the electrical energy is expended; *c* the secondary generator or converter; *d* the depositing cell; *e* a constant electromotive force.

Fig. 2. This is the diagram of an electric lighting circuit, coupled directly in parallel with the dynamo, as in the old low tension system, with a constant electromotive force *e*, and the depositing cell *d*, placed in the circuit, so that all the current which has to be measured passes through them. The differential action of the current causes an electro-deposition of metal by the influence of the electromotive force *e* on the alternating or main electromotive force, which, being exactly proportional to the amount of electricity passed through *b*, becomes a measure of the same, as before described.

Fig. 3. This is a diagram of a secondary generator or converter system, in which the primary and secondary circuits are coupled in parallel, the primary circuit a^1 inducing currents in the secondary circuit a^2 by means of a converter *c*.

The depositing cell *d* and the constant electromotive force *e* are placed in the secondary circuit a^2, thus becoming a measure of current, as before described in relation to Fig. 2.

In a secondary generator or converter system the secondary cell may be introduced into either the primary or secondary circuit, the depositing cell being in all cases between the secondary coil of the converter and the apparatus in which the electrical energy is expended.

Fig. 4. This is also a parallel secondary generator or converter system, in which the electromotive force *e* is placed in the primary circuit a^1, and the deposition cell *d* is placed in the secondary circuit a^2. The differentiation of the electromotive force produced by the constant electromotive force *e* in the primary circuit a^1 is reproduced by induction in the secondary circuit a^2 by means of the converter *c*. Electro-deposition results in the depositing cell, as before described.

Fig. 5. This diagram indicates one of several converters; *c* may be placed in series in the primary circuit a^1. This induces currents in the secondary circuits a^2, arranged in parallel with the appliances in which is expended the electrical energy. Both the constant electromotive force *e* and the deposition cell *d* are placed in secondary circuit, and thus become a measure for the electricity passed, as described in the preceding figures, in each individual secondary circuit.

Fig. 6. This is also a series secondary generator or converter system, having the constant electromotive force *e* in the primary circuit a^1, and the depositing cell *d* in each individual secondary circuit a^2. The same differentiation of the electromotive force produced by *e* being reproduced by induction in the secondary circuits a^2 by the converter *c*, as hitherto described in connection with Fig. 4.

Fig. 7. This is a parallel converter system. The constant electromotive force *e* in this case is used in a separate winding of the converter *c*. This, in combination with the primary circuit a^1, produces by induction in the converter itself the differentiated current in the secondary circuit a^2, electro-deposition resulting in the depositing cell *d*, as described previously in connection with Fig. 4.

We may mention that to obtain this differentiation, instead of a secondary cell, a primary cell or a dynamo may

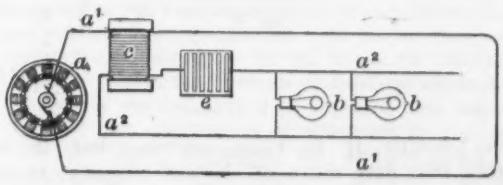


FIG. 10.

be used, or any other means of obtaining the desired effect.

The following is an example of another method of meterage and apparatus connected therewith, operating in the manner above mentioned, but using no deposition cell, the measurement being taken in the constant electromotive force cell itself.

Let it be required to measure the current duration of a number of lamps in a lighting circuit. We place in the lamp circuit, and in series between it and the generator, an electrolytic cell, which comprises two disimilar metals, placed in an acid or alkaline solution. When an alternating current is passed through this cell and the lamp circuit, the passage or flow of the current is alternately retarded or reinforced by the normal electromotive force set up in the cell itself, which subsidiary electromotive force causes a wasting or loss of weight of the positive electrode. As the resistance of the lamps in

*Abstract of a paper read before the British Assoc., Bath.

the lamp circuit varies according to the number and kind used, and the duration of the flow of current through the same, so does the current vary in the cell which acts upon the positive electrode.

This current is directly proportional to the electromotive force of the cell, and the resistance of the lamp circuit; the wasting away of the positive electrode, therefore, becomes available as a current meter.

Fig. 8. This is a diagram of a low tension circuit similar to that described in Fig. 2, but without the deposition cell *d*. In this arrangement one of the electrodes of the constant electromotive force *e* loses weight proportional to the electricity passed through the lamp circuit *b*, and this loss becomes a measure of the same, as before described.

Fig. 9. This is a diagram of a similar secondary generator or converter system as that described in Fig. 3, but without the deposition cell *d*. The electromotive force *e* in the secondary circuit a^2 has one electrode losing weight in the same manner as before described in the example of a low tension system given in Fig. 8.

Fig. 10. This is another series converter system, similar to that described in Fig. 6, but without the depositing cell *d*, the measurements being, in this case, obtained by the wasting away or deposition of the metal forming the electrodes of the cell *e* producing the constant electromotive force which causes the differentiation, as described in relation to Fig. 8.

This differentiation may also be produced by mechanical means. One of these is the addition of subsidiary coils upon the armature of the alternating dynamo, which is so arranged and commuted that it is cut out of the circuit during the second half of an alternation; or it may be so commuted that in the second half of the alternation its electromotive force is in the opposite direction to that of the dynamo—so giving double the differentiation of potential that it would in the other case. The current is commuted at the neutral point of the alternation, so that no high tension break occurs at any time.

Another method is to pass the alternating current through a coil having a magnetically saturated iron core, the result being that in the half alternation positive to the direction of the exciting current no retardation takes place, whilst that in the negative direction is retarded. To this latter method that described in Fig. 7 more properly belongs, except that in that case the exciting current is from the constant electromotive force *e*, round the separate winding on the iron of the converter, instead of round a separate coil having an iron core.

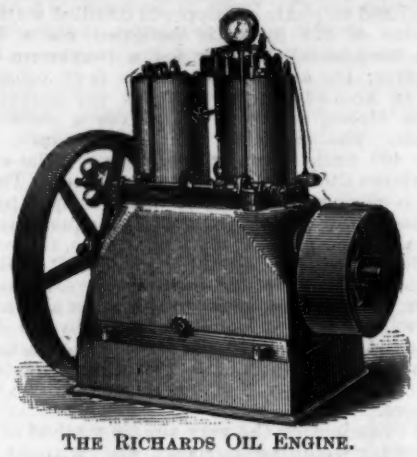
In a secondary generator or converter system, where differentiation is effected by these means, the same differentiation is reproduced by induction, and an electrolytic cell, or other means of measurement, is put in direct series between the converter and those appliances in which the electrical energy is expended.

This also can be applied in the diagrams, Figs. 2 to 6, the arrangements described being substituted for the constant electromotive force *e*.

The National Underground System.

One of the systems now in actual operation underground in this city at the present time, which has not so far been described in detail in our columns, is that of the National Conduit Manufacturing Company, of New York and Pittsburgh. What gives special importance to the system at this juncture is the fact that it will be adopted for the Westinghouse alternating current station at the foot of West Twenty-third street, and will be used in the district on both sides of the street, from Twelfth up to Fifth avenue; but it is noteworthy that fifty miles of it are already in service in this city, as well as large quantities in Chicago and Rochester. The main principle of the National conduit is the use of a wrought-iron cement-lined pipe, which can be laid singly or in groups. Fig. 1 shows the pipe, with the relative thickness of the iron and the cement lining. The pipe is usually made in lengths of 7 or 8 feet, of a diameter of bore of from 2 to 3 inches, and of an exterior diameter of from 3¼ to 4¼ inches for the trunk line pipes, and of 4 to 6 inches for the distributing pipes. Fig. 2 shows the pipe ready for the trench, and Fig. 3 shows the pipe when laid singly after the joint between sections has been made. In Fig. 4 a view is given of the multiple conduit for several classes of wires and for different services. The lower tiers are trunk line pipes, but the two outer ones in the upper tier are for distributing purposes, as shown in section in Figs. 5 and 6, the latter being the street box, accompanying illustration, are both water-packed, and are kept full to insure their coolness. The engine is built in all sizes from 2 to 25 h. p. by the Binghamton Hydraulic Power Company, of Binghamton, N. Y., and is claimed to be well adapted for electric lighting in the small isolated plants that have become so popular.

As seen in Fig. 5, the pipe is made with a slight ridge or shelf. Upon this is placed a board with guards. A wire or cable to be passed in is laid upon the board, which is then pushed or pulled, and travels easily along the conduit the desired distance, when the cable is dropped into the duct space beneath, where additions can be made from time to time as the demand for service increases. Distribution and the enlargement of distributing capacity are thus rendered very easy, and it is not necessary to bind oneself down to a predetermined size of cable or a definite and fixed number of lights. The tests that have been made in practical work show that the pure cement used affords a remarkably high insulation, while the iron is naturally an excellent mechanical protection. A specially good feature about the distributing pipes is that the method of drawing in avoids all rough contact with the walls of the duct, and hence the cables are laid as perfect as when they leave the factory. The lead covered form of cable is given the preference, and will be used in the Westinghouse work above mentioned.



THE RICHARDS OIL ENGINE.

The Richards Oil Engine for Small Lighting Plants.

Much ingenuity has been expended in the supplying of a cheap motive power for comparatively small users, and nearly all forms of fuel have been tried for the purpose. Oil or petroleum has been employed in some cases indirectly as a steam producer under a steam boiler, and in others as a direct means of obtaining pressure in a cylinder by explosion similar to the gas engine. In the Richards oil engine both these methods are departed from, the motive power being produced in the cylinder by the combustion of the oil vapor which has been mixed with compressed air. This mixture in the cylinder sustains continuous combustion, so that the pressure is obtained by direct expansion due to the heat and not by explosion, as is usually the case. The air used is compressed by the engine itself to any required density, from 60 to 100 pounds to the square inch.

The cylinder and air pump of the engine, shown in the paper, and numerous fine holes pricked in it. Instead of making these round with a needle, it is better to use the point of a penknife, which produces narrow triangular holes. The holes should be pricked both vertically in the direction of the radius of the filter, and horizontally, at right angles with the former; some of the holes should be pricked from the outside inwards, and the others in the opposite direction. Even with this arrangement, the filtration sometimes proceeds only very slowly, but it may be accelerated by using a filter-pump. A still better way to purify mercury by filtration, according to the same author, is the following: Select a glass tube, of about the thickness of a lead pencil, and about a yard long. Expand one end to the shape of a funnel, and the other to a tulip-shaped bulb, or expand this end in a wave-like form, such as is customary when rubber tubing is to be stretched and tied over the end of a tube. A piece of linen or chamois is firmly tied over the latter end, and the tube then suspended. On pouring the mercury into the funnel, it will be pressed through the pores of the filtering medium with a pressure considerably exceeding that of the atmosphere.

An Electric Tramcar in Paris.

The *Electricien* gives some interesting details of an electric tramcar built by Messrs. Phillippart Brothers, of Paris, and now being run between La Place de l'Etoile and La Porte Maillot, of that city, by the Compagnie Générale des Omnibus. The car which, fully equipped and with 50 passengers on board, weighs about nine tons, is fitted with 144 cells of the Faure-Sellon-Volckmar type, divided into four groups of 36 cells each, from which the current driving the motor is derived. These cells can in actual practice furnish power at the rate of 40 horse-power effective for six hours. The motor, which is of the Siemens type is placed at the forward end of the vehicle and runs at from 1,000 to 1,200 revolutions per minute. It drives, in the first place, an intermediate shaft by means of an endless band. The driven pulley is keyed to this intermediate shaft, but drives it and a sleeve riding loose on the axle through a differential gear, as in any ordinary tricycle, so that the sleeve and the axle can rotate independently. A chain pinion on the sleeve and another on the axle drive the two hind wheels of the vehicle, which can rotate independently of each other. This arrangement of differential gearing much facilitates the passage of the vehicle round curves and decreases the wear and tear. The speed of the car is regulated by altering, by means of a switch, the grouping of the accumulators, and four different speeds can be obtained. The car is also lighted electrically by means of six incandescent lamps of 10 candle-power.

Disruptive Discharges in Cables.

To the Editor of The Electrical World:

SIR: Mr. Brooks, in a recent letter to the *Electrical Engineer*, discusses the probabilities of disruptive discharges in cables, and evidently thinks he uses a clincher when he says, "How many lead encased cables have failed in this country when used for telephone purposes? Can it be said that they were destroyed by disruptive discharges when they were provided with lightning protectors, point discharges and plate discharges?"

This is a very pertinent question, and deserves an answer constructed upon the most exhaustive research. Mr. Brooks is not alone in the demanding of a truthful answer.

I have the pleasure of stating that I am at present engaged in the investigation of this subject, and have even now pushed my researches to such an extent that I may state positively that it is not only possible, but probable, that many cases occur where conductors in cables are "grounded" by atmospheric electrical discharges, even when provided with the *best lightning arresters*.

I hope at an early day to give the public the complete results of these investigations. E. G. ACHESON,

FIG. 1.

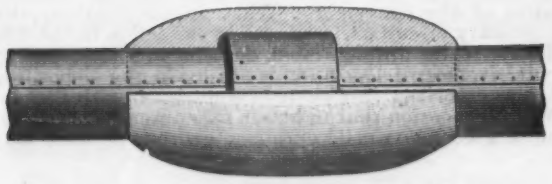


FIG. 3.

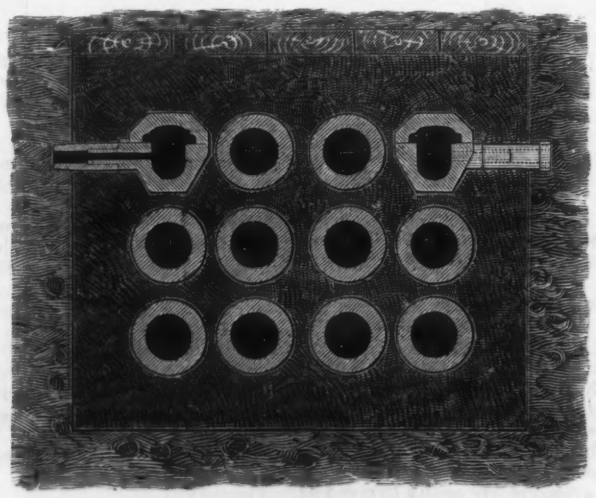


FIG. 4

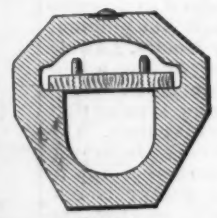


FIG. 5.

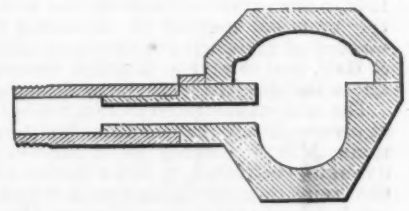


FIG. 6.

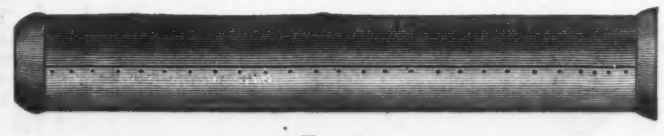


FIG. 2.

THE NATIONAL CONDUIT SYSTEM FOR ELECTRIC SERVICE.

Filtration of Mercury.

Mercury often becomes contaminated with alloys or other impurities which can be removed by simple filtration. This may be done in glass funnels, the stems of which are drawn out to a fine capillary tube. But this often becomes clogged after a short time, and then ceases to act; besides, it acts very slowly. Prof. C. H. Bohn, of Archaffenberg, in the *Zeitschrift fur Instrumentenkunde*, recommends a method which has long been practised in Bunsen's laboratory. A filter is made of writing

Proper Tests for Non-Magnetic Watches.

BY H. E. DUNCAN.

People operating or working around dynamos are often called upon to make or assist in some test intended to demonstrate the practicability, or otherwise, of non-magnetic watches, and in very many instances I have found people who think the only test is, if possible, to find some place on their dynamo, usually some corner near the armature, where the lines of force are concentrated sufficiently to retard the motion of the balance, and, in a few cases, stop the watch while in contact with the dynamo.

There are, unluckily, about the country a few old pattern dynamos that are rich in such points, and though they are quite successful in stopping watches, it is not to the credit of the efficiency of the dynamo.

A non-magnetic watch presents to the manufacturer the following problems for solution. Such parts of the movements as will become polarized—owing to the metal of which they are made—when brought into a magnetic field, and thus render the watch useless as a time-keeper, must be replaced by metals non-magnetic, that will give equally as good results in time keeping as well as in the problems of manufacture or durability. That tests of these qualities may be made by any one, and of a nature calculated to show only correct conclusions, is the object of this paper.

The parts of a watch most vital to its time-keeping are known as the balance hair spring and the escapement, and these parts are the most expensive to manufacture, as well as being those upon which the skilled adjuster shows his skill as a workman.

When a watch with these parts of the ordinary construction is placed within a magnetic field, the pieces feel the magnetism in the order named, and so retain it, after removal from the magnetic field. And in the watch of ordinary construction these parts are made mostly of steel, which is very sensitive to magnetic influences and retains it longer than any other metal; consequently it is the worst possible metal to use for such parts in this electric age.

Few persons outside of those engaged in watch manufacture, can realize the obstacles to be overcome in making these parts named of non-magnetic alloys that had all the properties of steel in expansive ratio, elasticity, as well as to weld, turn and polish; in fact, a book could be written entitled "Recent Problems of American Watch-Making," that would be very interesting reading, especially to such manufacturers as have not passed the experimental stage.

And it is no idle boast when I say that an alloy hair spring is now made by the Waltham Watch Company that is better than steel for a watch hair spring, and the elasticity is not a property of hammering, rolling or drawing, but of the alloy, and that the spring can be heated to a red heat and in no way anneal or change the elasticity, as it would, were it a property of artificial hardening; and the spring daily shows better results than the older and more uncertain fire hardened steel hair spring.

To test a watch for any purpose it is necessary to know how it runs, or, to be more exact, what its daily variation is by some standard clock, and this is known as the daily rate. The watch must remain in the same position throughout the trials, that the conditions may be the same, as no watch but has an error, so called, due to change of position, this error being the smallest in the highest priced watches.

And for the benefit of those who think otherwise, let me say no watch ever keeps perfect time, nor can such a watch be made. After having found what its variation is for the twenty four hours, expose the watch to some strong magnet or dynamo, at the distance it would be when in the pocket, and for about the length of time a person would be in the field of the dynamo, if in attendance, and, having noted the time by comparison with the standard, again note the time after the exposure to the dynamo, and note the error, if there is any.

This test (the most crucial) will have but one value, and that will be in deciding whether it is possible to carry a watch round a dynamo and be sure of accurate time, unless you avoid some point where the lines of force are concentrated. In some such cases presented to my personal attention I have found the magnetic force outside the dynamo stop the watch, due to the steel second hand being held by the magnet, and by replacing the hand by one of gold the watch was not in the least affected by the dynamo.

I have yet to find a case where a Waltham non-magnetic watch could not be carried by a dynamo attendant *in his pocket* around the dynamo when in attendance, without disturbing its running or time keeping qualities, but I think a magnet could be made that will stop a watch that was made wholly of copper; and I think I have the support of some of our most eminent electricians in this country in this statement.

And before resuming the last and decisive test, I wish to say a word to such as have so often as a test placed their watch upon a dynamo and left it to run for a period of twelve or fourteen hours; that it is a test that no sane man would deem fair, as it usually ruins the balance pivots by so doing, as the balance arbor or shaft is a small piece of steel about one-eight of an inch long and about the size of a cambric needle, the ends or pivots turned down to about four one-thousandths of an inch and running in jewels; and when the watch runs for a few hours in an intense field, these little pivots are drawn to one side of the jewel, with force sufficient to wear, and often bend them, and thereby causing the watch to run badly till the proper repairs are made or a new arbor is put in.

We now come to the final test of the watch, which can be readily decided. The rate or daily variation of the watch being known from the first trial, and it having been exposed to a magnet that would have rendered an ordinary watch useless instantly, it only remains to repeat the first trial under the same conditions of position, temperature and duration of time of trial, comparing the difference with the first rate of the watch obtained, and the difference, if any, will be due to the magnetism remaining in the watch.

Dynamo attendants form but a very small part of the watch-carrying public, who require a watch that will not be rendered worthless by magnetism, and who are liable to come within the field of some magnet for a short time and do not know it till their watch shows some freaks as unexpected as they are undesirable. Yet such dynamo attendants are the persons that usually make the test of the non-magnetic watch for themselves and friends, and, if this little sketch of a proper test aids them in so doing, its aim will be accomplished.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
168-177 POTTER BUILDING, NEW YORK, Nov. 12, 1888.

New Address.

The American Electric Construction Company has taken Rooms 3, 4 and 5 in the Smith Building, 15 Cortlandt street.

T. F. Hunter & Co.

The above firm, of 37 Church street, manufacturers' agents and dealers in general electrical supplies, announce that W. L. Adams has retired from the concern. The business will be carried on at the same place and under the same name, by T. F. Hunter and H. C. Willis.

Long Distance Telephone.

A special and new feature of the election returns this year was the use of the long-distance telephone from points as far away as Buffalo. All the leading dailies utilized the service to advantage, and the announcements on the boards and stereoptiçon stands were frequently headed, "By long-distance telephone."

Edison Isolated Plants.

Mr. C. A. Benton, the well-known Edison agent, has just completed a 175-light installation for the Bradley and Currier Co., Limited, in their new factory, 230 Spring street, and has shipped a 100-light machine to Hackett & Atwood, Empire Mills, Utica, N. Y. He also closed a contract last week with P. Doelger, for the brewery at Fifty-fifth street and First avenue.

The Thomson-Houston International Company.

The Thomson-Houston International Electric Company has opened a branch office in New York at 115 Broadway (Boreel Building), and Mr. Louis W. Magee will have charge. Mr. Magee will spend half his time at the New York office and the remainder at the Boston office, *i. e.*, Tuesday, Wednesday and Thursday in New York, and Friday, Saturday and Monday in Boston.

The Hazelton Upright Boiler.

This appliance, built by the Hazelton Boiler Company, of 145 Broadway and 716 East Thirteenth street, is an improvement in what is known as the water-tube class of boilers. It requires very limited floor space, is economical of fuel and rapidly produces an abundance of perfectly dry steam. It is now in use by the New Britain (Conn.) Schuyler Electric Light Company, one 125 h. p.; Meriden (Conn.) Electric Light Company, two 150 h. p.; United Electric Light Company, Springfield, Mass., three 215 h. p.; Excelsior Electric Company, Orange, N. J., one 150 h. p., making a total of 1,310 h. p. in use by these companies alone.

The Hussey Battery.

As an instance of the work of the Hussey battery, made by the Eclipse Electric Company, of Greenwich and Liberty streets, this city, I may mention that one of them has been driving, every day since Oct. 7, one of Pearce & Jones' motors attached to a turntable for showing goods. Pearce & Jones speak in high terms of the battery, especially because it will take the place of the cumbersome lead box and zinc hitherto used. The battery is convenient to handle, only water is used in setting it up, and it will give a steady current of 5 ampères and 1 6 volts. It will give a higher yield with an exciting acid, but will not hold up so long. The battery is not only desirable for light motor work, but is well spoken of for local and long distance telephone service. A continuous amalgamation of the zincs goes on, there is no "creeping" action, and the only renewal practically is that of the porous cup.

The Improved Business of the Cable Companies.

Considerable talk has been caused in commercial and financial circles by the announcement of the intention of the Commercial Cable Company to increase its capital stock from $6,000,000 to $10,000,000, and by the further fact that it contemplates taking up its outstanding bonds as fast as they mature, anticipating a large proportion of them, and replacing them with stock. It is said that up to the present time about $600,000 worth has been retired. This movement on the part of the company is understood to be due to the better condition of the cable business since the late rise in rates, and to the fact that the company has now a good paying business to the utmost capacity of its cables. This is the direct result of the termination of the cable war which has been waged so stubbornly for the last two years between the Cable Pool and the Commercial Cable Company. This termination, it will be remembered, was brought about by a common agreement on a rise from 12 to 25 cents per word, and a minimum of three words per message, from the 1st September last. With a view to learning what effect this improvement in rates had on the general business of the companies, Mr. George G. Ward, the general manager of the Commercial Cable Company was interrogated. He states that up to the present there is no reason to be other than satisfied with the change. Mr. Brown, the general manager of the Direct Cable Company, thinks it is too early to form any opinion on the subject; at least six months working on the new basis should be allowed before doing so. Perhaps, in their business there might have been the slightest possible falling off in messages, but this is not appreciable, and not as much as they ordinarily look for at this time of the year. Mr. Austin, General Manager of the French Cable Company, reports an increase in their business. This, he thinks, is attributable to the activity in cotton and coffee, but he is of opinion that a few months must elapse before a safe conclusion can be arrived at as to the effect of the change of rates.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
178 Devonshire Street, Boston, Nov. 12, 1888.

The Electric Gas Lighting Company,

35 Arch street, Boston, are turning out a number of their largest size annunciators, among which is one of 200 numbers for a hotel at Thomasville, Ga.

Water Wheels.

P. H. Holmes, of Gardiner, has placed the second Holmes water wheel in the Great Falls, N. H., Manufacturing Company's mills, and will probably place a third there.

New Damper Regulator.

The Mason Regulator Company, of Boston, has commenced the manufacture of a damper regulator. This company is building a two-story factory at Dorchester Mass., for the manufacture of steam regulating specialties.

Electrical Securities.

Messrs. R. D. Wilson & Co., No. 113 Devonshire street, Boston, have decided to devote their entire time and attention to handling electrical securities of all kinds. They will sell bonds and stocks of the various electric light and electric railway companies.

Another Consolidation.

The Simplex Electrical Company, of Boston, has bought the stock in hand of the Campbell Electrical Supply Company, of that city, and will hereafter control the sale of the entire product of the latter company's factory. It is proposed to maintain the reputation which the Simplex Electrical Company has acquired of handling high grades of goods, by making at its factory an insulation superior to that heretofore turned out there.

New Electric Light Station.

The building of the Boston Electric Light Company's fine new central station on Atlantic avenue and Congress street, is progressing, and it is expected will be nearly, if not quite, completed in three or four weeks. The company uses the Brush, Weston, Thomson-Houston and American arc systems, and one or two incandescent methods, and does a very large business from its four existing stations; and the new one will add greatly to its already extensive facilities.

Personals.

Mr. M. W. Baird, of the Eddy Electrical Manufacturing Company, who has been traveling in the Western States, has returned to his home after a successful trip.

Mr. J. F. Meech, the European manager of the Thomson-Houston International Electric Company, arrived home October 27, after three years' absence. Mr. Meech was accompanied on his homeward trip by Mr. F. J. Down, of the firm of Messrs. Laing, Wharton & Down, the London, England, representatives of the Thomson-Houston International Electric Company. Mr. Down will remain in this country about a month, and will make his headquarters at the Thomson-Houston Electric Company's Boston offices.

Electricity at The American Waltham Watch Company.

I have had the pleasure recently, through the courtesy of Mr. H. E. Duncan, of paying a visit to the above great factory, of which Mr. Royal E. Robbins, the treasurer, is the moving spirit. The works employ 2,600 hands. I would like to go into details, but must forbear, knowing the demands on your space. The dynamo room and steam plant of the factory combined constitutes one of the most complete and costly isolated electric light stations in the world. This comprises three spacious departments, viz.: the dynamo room, engine room and boiler room, the walls and ceilings of the first two being richly dressed in black walnut and white oak. The Waltham Watch Company were among the first to adopt electric lights as an illuminant. Reaching the limit of their engine to furnish power for the production of light by means of a dynamo, they made trial of the system of secondary batteries by installing a plant of 300 cells of the Julien storage battery, charging them by the dynamo during the daylight and then using the machine for direct lighting, supplemented by the batteries, giving about 700 lights in all.

The results of the introduction of the electric light, in the comfort and health of the employés, have been so satisfactory that the company have during the past summer felt justified in incurring a heavy expense in very greatly enlarging their electric plant, which they have done by the introduction of four Mather dynamos of the new and improved pattern, each machine of nominally 500 16 c. p. lamps capacity, though capable of considerably exceeding that number. This required the building of a special room for the dynamos, and the providing of additional boiler capacity, the erection of an additional steam engine, and in connection with that the remodeling and radical change in the main shafting. The four dynamos, while each complete in itself, and each furnished with its voltmeter, ammeter, rheostat, etc., are so arranged by a system of switches that one may be used for charging the storage cells, while the others at the same time can be used for direct lighting, or the entire number can be used for storage charging; or they may all be used for direct lighting, as they are arranged to feed into very heavy "bus" wires, from which the current can be sent to any one or all of the 20 or more departments. Or some department may get its light by direct current from the machines at the same time that other departments are lighted through the storage batteries.

These arrangements also enable any room to be lighted, if desired, without the necessity of running the engines and dynamos. I believe this switch board to be as complete and as fine a piece of work as can be found in any electric light station, and certainly it is a great credit to the Mather Company. The new engine is a counterpart of the one in use for supplying the needful power to drive the hundreds of machines required in the manufacture of watches, and is so arranged that the two can be connected and disconnected or alternated in their use without in the least disturbing the uniform speed of the main shafting. This ability is attained by the employment of two of the improved friction clutches furnished by H. N. Bates & Co., of Boston. The changes in the main shafts were made during the annual summer vacation, avoiding any interruption of the regular manufacture. The power plant of the factory now consists of six horizontal tubular boilers aggregating about 550 h. p., and two Corliss Steam Engine Company's engines, giving about 320 h. p. Besides this they have one 7 h. p. portable and three 10 h. p. uprights to be used in the manufacture of fuel gas by a new and improved process.

The electrical appliances of the factory are numerous and varied, and consist of the four Mather dynamos, 500 lights each, one U. S. dynamo 200 lights, one Maxim dynamo used for running a single arc lamp for photo printing, two Weston and one Wallace dynamo for nickel plating and gilding and 300 cells of storage battery. In addition to the foregoing is a complete time signal system, giving the vibration of the pendulum of the astronomical clock in all the departments where watches are

timed. Then they have a complete telephone system, with a central office with its switch-board from which radiate 10 lines with about 80 telephones, beside three telephones connected with the suburban exchange. Each department using machinery is provided with electrical connection with a large gong in the engine room to signal for stopping the engine in case of accident. The engine room is also provided with an electric tell-tale giving the height of water which is pumped into the immense tanks, located in each of the two main towers, and from which the water is carried to the various rooms of the factory. Of course, like every well regulated factory, this one is provided with a watchman's electric time detector, and in each department is an electric gong connected with the office of the doorkeeper, who operates them all simultaneously by the movement of a single switch announcing the instant for commencing and ceasing work, and also to give notice of a fire alarm, this latter use being occasioned by the fact that the chief of the city fire department and some of his assistants, and very many of the firemen, are employed in the factory.

A fact already familiar to many of your readers is that this company are manufacturing non-magnetic watches, not only of every grade, as regards quality and accurate time, but thoroughly proof against the influence of the powerful magnetism generated by dynamos or electric motors. Mr. D. W. Eldridge, the chief inspector of the factory; Mr. John Logan, foreman of the hair spring and main spring departments, and Mr. J. L. Keyser, foreman of the balance department, constitute the indefatigable trio who have devoted several years of patient yet untiring labor in experimental and testing work in bringing to a successful stage the Waltham non-magnetic watch. The first named gentleman demonstrated to me the peculiar merits of his company's non-magnetic hair spring. First he stretched out the spring to a distance of five inches, having the appearance of a long spiral thread; then suddenly releasing one end, the spring at once returned to its original coil without evincing the least sign of "cupping" or spreading. Then Mr. Eldridge placed the same hair spring upon a miniature metal shovel and held it over a spirit lamp, and allowed the wire to remain until heated to a blood-red color. The spring was again pulled out to nearly its entire length; and one end being released it returned as before to its original coil, without showing the least effect from the severe test to which it had been subjected.

In the department presided over by foreman Edgar L. Hull, the dials are made, figured and otherwise prepared for the watches. One of the most novel features in the factory, and one of especial interest to electrical people, is to be found in this department. An arc-light is suspended at one end of the room which forms the principal factor in the apparatus for photographing figures on the dials. Mr. Hull is very proud of this electric photographing machine, and justly so, as it is the result of his ingenuity and untiring labor. It will turn out five distinctly printed dials at a time.

I desire to extend my thanks for courtesies also received, to Mr. F. Fisher, foreman of the escapement room; Mr. C. R. Hill, foreman of the train cutting room; Mr. Leonard Greene, of the plate department; Mr. Charles Moore, and to Master Mechanic Mr. E. A. Marsh. To the last named I am especially indebted for information received regarding the dynamo and steam plants of the factory, both of which are in his charge. W. I. P.

AMESBURY, Mass., Nov. 7, 1888.

The Amesbury Electric Light Company are now getting along rapidly with their new station, which is of brick, 40 × 60, three stories high. Their first boiler has arrived and their engine is expected daily. Their engine and boiler room will use the entire lower floor or basement, and be about equally divided in size. They will put in at first a 125 h. p. Rollins engine and a 150 h. p. Cunningham boiler, with provision for a 250 horse engine and condenser, and two more boilers, making their total steam plant over 400 h. p. The second floor occupies but half of the building, *i. e.*, the room over the engine room, and is to be used for storage, etc. On the third floor is the dynamo room, which includes all but a room 10 feet wide across one end, to be used for an office and testing and repair rooms. In this room will be a 5-inch shaft 22 feet long coupled to 20 feet of 4-inch shafting running in the centre of the room. The dynamos will be located on both sides of the shaft, and there is room for fourteen. Each engine is to belt to a friction clutch pulley, and in case either engine breaks down or heats the other one can easily be thrown on to do the work without any stoppage. The company are now wiring for their new alternator, and the prospects are that a large number of lights will be taken before spring for houses and stores. The company are also setting poles for the horse railroad between Amesbury and Merrimac, which it is proposed to have running by electricity early next spring.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
39 South Tenth Street, Philadelphia, Pa., Nov. 10, 1888.

Telephone Infringement.

Counsel for the American Bell and Pennsylvania Telephone companies have filed a bill of complaint in the United States Circuit Court asking to have the firm of Hoke & Apperzeller and William McKnight, of Chambersburg, Pa., enjoined from using telephones alleged to contain infringements on the patents granted to Alexander Graham Bell.

Combination Fixtures.

Messrs. Horn, Brannen & Forsyth, of this city, have recently furnished a splendid lot of combination gas and electric light fixtures for the post office building in St. Louis, and for the new building of the Chamber of Commerce in Cincinnati. The U. S. Electric Light Company obtained the contract for the St. Louis building. The four chandeliers, of 32 lights each, in the main room of the Chamber of Commerce are exceptionally fine specimens of artistic combination fixtures.

The Murray Glass Works.

I spent a very pleasant hour one day last week at the new glass works of James J. Murray, and through the kindness of Mr. Murray I was enabled to inspect what is believed to be the most complete flint-glass factory in the country. The establishment is completely new, and affords many advantages which could only be possessed by an entirely new plant. Not the least of its splendid features is the fact that it is the coolest factory in existence, being built on an open elevated space, and the windows and ventilating openings, which are on all four sides of the building, are so situated that the greatest possible amount of fresh and cool air is always obtained, thus adding immensely to the comfort of the workmen. The main building is 170 by 215 feet in dimensions, with a three story and basement extension building, 110 by 60 feet, adjoining, in which are the cutting, grinding and etching departments and the boiler and engine. The factory contains one eleven-pot furnace, five glory holes, and four annealing ovens. The capacity of the works for arc and incandescent light glass ware is the largest, it is said, of any establishment in the country, and the work includes all known shades and styles of flint glass, such as opal, flint, ruby, etc., and 180 hands, whose weekly salaries aggregate over $2,000, are employed in turning out the goods for the market. Mr. Murray has an experience in the glass blowing industry which extends over a period of 18 years, he having been a member of the firm of Gill and Murray for ten years, where he achieved a reputation which warranted him in building the present factory on a scale which eclipses anything of its kind, it being the best equipped and having the best furnaces in the country. From the start the factory has been crowded with work, and goods have been shipped to every portion of this country and Canada. E. W. E.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
44 Lakeside Building, Chicago, Nov. 10, 1888.

Personals.

H. O. Woodruff has been appointed superintendent, and L. G. Nilson electrician of the Des Moines Edison Light Company.

Oshkosh, Wis.

The Oshkosh Electric Light and Power Company are increasing their plant with 500 incandescent lights of the Thomson-Houston alternating system.

Pendleton, Oregon.

A plant consisting of 50 arc lights, Thomson-Houston system, is to be put in by the Pendleton Electric Light and Power Company. The purchase was made through the Western Department of the Thomson-Houston Company.

Portland, Oregon.

The United States Electric Light and Power Company of this city are increasing their plant by the addition of 50 Thomson-Houston arc lights. Fifty lights of the same system, it will be remembered, were purchased in August last.

Incandescent Light from an Arc Light Circuit.

Mr. E. R. Weeks, general manager of the Kansas City Electric Light Company, is, I learn, lighting his house with incandescent lights, the current for which is furnished from an incandescent generator operated by a Baxter motor upon an arc circuit.

Power.

The Sprague Company sold in Des Moines, Iowa, last week a 10 h. p. motor for the Iowa *State Register*, a 5 h. p. for the Western Lithograph Company, a 3 h. p. for Cheshire Brothers, all for printing presses. Orders were taken by H. O. Woodruff, their local agent.

The Western Electric Company.

The Western Electric Company have just been fitting up their offices in a handsome and substantial manner. A portion of the floor has been relaid with different kinds of wood and new partitions have been constructed, separating the offices of the different departments. The work was completed and the company moved back this week from its temporary quarters.

Baxter Motors.

The Chicago *Herald* has, through the Western department of the Baxter Company, bought a 4 h. p. motor for use in one of its departments. Peak, Mauritzon Company, railroad printers of Elgin, Ill., and A. Houtkamp & Son, of Milwaukee, Wis., printers, are each putting in a two h. p. Baxter motor. The new organ of the Angestorm College, of Rock Island, is to be blown by a one h. p. motor.

Change of Office.

The Western branch office and salesrooms of the C. & C. Electric Motor Company, F. N. Armour, manager, have removed to the new Edison building, 139-141 Adams street. The offices are pleasantly located on the ground floor, and I learn that a full line of various sizes of motors will be kept on hand besides duplicate parts of motors. Mr. Armour is to be congratulated upon his pleasant location.

A Bain Arc Light Switch-Board.

A ten-circuit arc light switch-board has just been completed by Forse Bain, electrical engineer, and shipped to the People's Electric Light Company, of Trenton, N. J. This switch-board is similar in construction and principle to the large one illustrated recently in THE ELECTRICAL WORLD, built for the Louisiana Electric Light and Power Company, of New Orleans. It is equipped with five ammeters.

Telephone Quotations.

Col. S. G. Lynch, broker, 146 La Salle street, furnishes quotations upon telephone stock as follows:

Bell of Mo.	$150@	$155	Iowa Union	$28@	$29
Central Union	47@	48	Michigan	81@	82
Chicago	338@	340	Missouri and Kansas	70@	71
Colorado	43@	46	Rocky Mountain Bell	41@	43
Cumberland	68@	70	Wisconsin	116@	118
Great Southern	34@	37			

Sale of Alternating System Lights.

Mr. R. T. McDonald, manager of the Fort Wayne Jenney Company, was in the city one day last week, and from a conversation with him your correspondent learns that the factory of his company is kept running very busy at present turning out apparatus for both the arc and alternating systems. The company are also commencing the manufacture of their new alternating motor, the invention of Mr. Slattery. During the week previous Mr. McDonald stated that the company had sold lights of the alternating or induction system to the following, a record of which the company may well feel proud: Madison, Wis., 1,000 lights; Grand Forks, Dak., 800 lights; Fargo, Dak., 800 lights; New Brunswick, N. S., 500 lights; Grinnell, Iowa, 1,200 lights; Swift & Co., Chicago, 4,000 lights; Swift & Co., Omaha, 650 lights; 2 plants in Texas, 1,200 lights; Cent. Elec. Lt. Co., Chicago, 5,000 lights.

The Central Electric Company.

I learn from the Central Electric Company, who are the Western agents for the Butler Hard Rubber Company, that the latter company are just out with a new patent compound for rubber tubing, rods and sheet rubber, and in fact, it is to be used for the manufacture of all goods for electrical purposes where rubber is now used. The special claims are that it is cheaper than rubber, a better insulator and easier to handle. The company have already orders booked for the material. The demand, too, for general electrical supplies, especially wire, etc., I also learn is very brisk at present. The business of the company is, on the whole, increasing very fast. I may also add that the company have recently brought out a new skeleton bell, which apparently has some very good points in its favor. The gong is cast metal, which it is claimed is a special advantage. A large number of orders have already been received for the same. Among recent orders for wire and cables the company report the sale of an Okonite submarine cable No. 6, to be used for electric light service. A little folder, descriptive of Okonite wire and tubing, has just been issued by the company.

The Topeka Electric Railway.

Mr. J. H. Shay, who has just returned from a trip to Topeka, Kan., furnishes me with an interview, published in a local paper of that city, with Mr. McIntire, mechanical engineer of the railway department of the Thomson-Houston Company, who has just arrived to install the electric plant which is to supply the motive power for the new rapid transit railway. Mr. McIntire said: "The electric plant which we propose immediately to instal in this city will be the largest in the world for railway purposes. We shall at once put in seven 100 h. p. generators, and provision will also be made for an increase of the plant. These generators are to supply the current by means of an overhead wire. The power necessary to operate the generators will be furnished by two Corliss engines, one 250 and the other 450 h. p. These engines are of the latest improved design and are made exceptionally heavy in every part to insure reliability. They will be connected by means of friction clutches, so that they can be operated separately or together. The boilers which are to supply the steam for the engines will be 6 feet in diameter, and made of the very best steel, set in brick masonry. The boilers have an aggregate capacity of 800 h. p. The station in which the electric plant is to be placed will be located at the corner of Second and Jefferson streets, and will consist of a building 85 by 100 feet, one-half of which will be two stories high. The structure will be of brick and stone. A brick chimney will also be constructed, 125 feet in height. We will begin work on this plant at once; in fact, we began work on the chimney yesterday. We shall positively have the plant in operation on or before Jan. 1 next. When it is completed, Topeka will have the most extensive electric railway system in the world as well as the most complete in all its appointments. There can be no doubt whatever as to the success of this system, as the electric current is capable of developing through the motors under each car all the motive power necessary to drive the cars as fast as is practical to run them in the city, say from six to ten miles an hour." I may add that Mr. Shay, who is the representative of the Chas. Munson Belting Company, while in Topeka arranged with the railway company for furnishing the belting to operate the plant as follows: 125 feet of 40-inch main belt, 125 feet of 24-inch main belt, 400 feet of dynamo belting.

San Diego, Cal.

A correspondent writes me from San Diego, Cal., as follows: For two months past H. M. Wilson, representing Frank S. Marr, the electrical contractor, of Pittsburgh, has been actively engaged in installing a 1,300 lamp Westinghouse plant in this city for Geo. D. Copeland, President of the Electric Rapid Transit Street Car Company. At present between eight and nine hundred commercial lights have been placed and the prospect is that in three or four months Mr. Marr will have completed the contract with Mr. Copeland, and the plant will be turned over to the latter. Two 650 Westinghouse lighters are now being placed in the works of the Rapid Transit Company, it being proposed to use the steam plant by day for generating the current for the street car system and by night for lighting. As soon as the plant is in operation, about 2,000 incandescent lights will be in use in the business portion of San Diego. As yet nothing has been done toward incandescent lighting in other portions of the city other than the wiring of a number of new residences. The Westinghouse people intend to start up at once a 1,300 lamp installation in South Riverside. Lights will be furnished to consumers both in Riverside and in San Bernardino, the latter being about seven miles distant from the works. The dynamos will be run from a 250 horse-power turbine, the water for driving which is to be obtained from a large flume that has just been completed.

The Indianapolis Jenney Electric Lighting Company, which has the contract for lighting the city of San Diego, is placing another 125-foot mast, making ten masts in all.

Competition in the incandescent lighting business in this city is quite sharp: First came the Edison people; they installed a plant in the Pierce-Morse Building, of 600 lights. About 260 lights were used in the Pierce-Morse Building, and the rest were placed in the business community. Then came the Westinghouse people with their 1,300 lights, and now the Indianapolis Jenney Company announces that it is prepared to make contracts for furnishing incandescent lights on the series system. The Indianapolis Jenney Company plant in this city is owned by the San Diego Gas and Electric Light Company, and it is apparent that the inroads that the other incandescent lighting people were making upon their gas interests forced them to establish an incandescent department.

I notice in THE ELECTRICAL WORLD of Oct. 20, during the session of the meeting for discussing Mr. Sprague's paper on "Electric Railways," reference was made to the gearing used in the Henry system in Kansas City, and doubt was expressed as to whether the same was in use in the road running in San Diego,

and also as to whether the road was in use. Mr. Henry's road is running in San Diego, and has been doing so, with hardly the loss of a week's time, since December last. The few days that were lost were caused by a fuel famine. Adjustable leverage is used in the gearing, which gives satisfaction, with the exception that when the gearing is new it is too noisy; but it soon wears down and runs smoothly. As yet the gearing has never been found wanting, and on Sundays a single motor weighing 1,400 pounds has frequently carried a train of two cars up a nine per cent grade, each car holding about 65 people. In order to test the efficiency of the motor and of the system in general, a time table test of two weeks duration was made recently, and it was ascertained that the average daily loss at switches, etc., during that time was but nine minutes, four trains being on the road. According to its franchise, the company is permitted to run its cars at a speed of eight miles per hour in the city limits, but the company contemplate in the near future putting a car on its University Heights extension that will attain a speed of 15 miles per hour.

For some weeks past, the City Council have been debating upon the advisability of installing a fire-alarm system. The only parties who responded to the advertisement for bids were T. H. Rhodes, the Southern California agent for the Gamewell Fire Alarm Telegraph Company, and J. B. Gill, Manager of the San Diego District Telegraph Company. Mr. Gill submitted a bid in which he agreed to furnish a Gamewell plant of 15 stations complete, with gongs, indicators and central office apparatus, for $3,750, while Mr. Rhodes' bid on a Gamewell automatic central office installation was about $1,500 in excess of Gill's figures. This being the case, the city fathers leaned towards Gill's proposition, until Mr. Rhodes asserted, and backed his assertion by letters from the Gamewell people, that Gill had not power to furnish the Gamewell apparatus, and that if the city should accept his bid, it would doubtless buy itself into a lawsuit. As yet, the matter is unsettled, but if Gill "gets there," the Gamewell people will probably be heard from, and the fur will fly. San Diego is now a city of 30,000 inhabitants, and its fire-alarm system consists of one bell, numerous police whistles and unnumbered revolvers which are fired off into the air every time a threatening flame is seen. Indeed a fire alarm in San Diego is a veritable Haymarket riot.

E. L. P.

THE TELEGRAPH.

Norwich, Conn., is to spend $2,000 for a fire-alarm system.

Ashland, Wis., has authorized the expenditure of $2,000 on a fire-alarm system.

The T. M. B. Association.—The annual meeting of the Telegraphers' Mutual Benefit Association will be held in the Western Union Building, 195 Broadway, at four o'clock, on Wednesday, Nov. 21, 1888.

THE TELEPHONE.

Erie.—The Erie Telephone Company has declared a regular quarterly dividend of three-quarters of one per cent.

Long Distance Election Returns.—The New York *Evening Post*, speaking of the long distance telephonic work at the New York end, says that "over a distance of 700 miles, which the lines of the Long Distance Company cover from Boston to Buffalo, all the unimportant villages connected only with local offices had the news as soon as it reached any one of the receiving offices of the Long Distance Company. Several times during the day it happened that election returns from Philadelphia, Albany or Buffalo were sent from New York to small towns around Boston or to particular points in Boston in less than sixty seconds. Next year the long distance lines will reach Chicago and all the towns upon the lines between Buffalo and Chicago; and beyond that they will run to Detroit and Milwaukee, the line between Chicago and Detroit being already built. To the south they will reach Washington. The best proof that long distance service is of practical value to the country is that between New York and Boston there are now no less than forty wires in use, where a year ago there were not twenty, and yet the company is often troubled for want of more wires."

THE ELECTRIC LIGHT.

Centreville, Md., is organizing an Edison Company.

Maquoketa, Ia., is putting in a new electric lighting plant.

Evansville, Ind., is to have a Westinghouse plant of 1,700 lights.

Anaconda, Mont.— City lighting is to be done by the Anaconda Copper Company.

Lexington, Ky.—The plant of the Lexington Electric Light Company is, it is said, to be enlarged.

Jersey City, N. J.—The Mutual Electric Lighting Company, of Jersey City, has been incorporated by S. M. Young and others, with a capital stock of $100,000.

Wilmington, N. C.—The Wilmington Electric Lighting Company contemplates an enlargement of plant, but nothing definite has yet been agreed upon.

Indianapolis, Ind.—The Incandescent Light Company, of Indianapolis, has been formed by H. Jameson, T. H. Spann and others, with a capital stock of $40,000.

Boonville, N. Y.—The Boonville Electric Light and Power Company has been organized by C. E. Thompson, A. J. Schweinsburg and others, with a capital stock of $10,000.

Buena Vista, Cal.—The Buena Vista Electric Light Company has been incorporated by H. H. Daniels, J. Tipton, G. S. Wood and others with a capital stock of $15,500.

Natchez, Miss.—The Citizens' Electric Light Company propose to add capacity for 1,500 incandescent lights. It is reported at a Thomson-Houston plant is to be installed in the city.

Nashville, Tenn.—A company has been organized by J. F. Cowan and E. D. Davidson, of New York, and J. A. Drake and F. J. Richters, of New Jersey, to do an electric light and power business.

Gainesville, Tex.—The Gainesville Gas and Coal Company has changed its name to the Gainesville Light and Fuel Company, and will do an electric light business. Mr. E. L. Hopper is the superintendent.

Philadelphia, Pa.—Edward W. Tisdall, special agent of the Brush Electric Company, has recently sold a 62 to 65-light Brush arc light machine to be used for central station purposes in Philadelphia.

Phœnixville, Pa.—Mr. J. L. Janeway, lessee of the Phœnixville Gas Light and Fuel Company, has bought out the Phœnixville Electric Light and Power Company, and proposes to sell electric light at the price of gas.

Athens, Ga.—The Athens Gas Light Company are to put in their electric light plant at once at a cost of $15,000. Mr. C. D. Flanegan, the superintendent, has applied to the City Council for the usual rights and privileges.

Hagerstown, Md.—The Schuyler Electric Light Company, of Hagerstown, have installed a 1,500 incandescent electric light plant of the Westinghouse alternating system, which is expected to start up on or about Nov. 13. The plant was constructed by the Marr Construction Company.

Concord, N. H.—The contract for furnishing the combination electric light and gas fixtures for the government building in Concord, N. H., has been awarded to the Schultz Gas Fixture and Art Metal Company of Baltimore, Md., at $1,352.55. They have eighty days from Oct. 4 to complete the contract.

The Electric Lights Were to Blame.—The schooner "Beamer," from San Blas, grounded on the Romer Shoals while coming in from sea last evening. She was floated in fifteen minutes, leaking badly. The captain attributed the mishap to the new electric lights of Gedney's Channel. Of course.

Northern Michigan.—The Calumet & Hecla Company, who have been using Brush electric lighting apparatus in Northern Michigan for some years, have just arranged to increase their electrical plant by ordering through Alexander Kempt, special agent for the Brush Electric Company, a new 28 to 30-light dynamo and some additional lamps.

The Silvey System.—The 300-light incandescent plant installed by the Silvey Electric Company for the Ada Electric Light Company is to be increased to 600 light capacity as soon as the additional dynamo can be set up. There are 36 lamps of 100 c. p., which the people prefer to the ordinary arc light, but a 25 arc light Silvey plant is to be installed for street lighting.

The Richter Dynamo.—The Richter Electric Company, of Camden, N. J., write us that that the machine shown in operation, mounted on an Otto gas engine, in our issue of Nov. 3, is their dynamo. The combination appears, as we then remarked, to be of a highly practical and useful character, and the company claim that excellent economy in the use of the electric light instead of the gas, at the burners, is obtained.

The Hawkeye System.—The Hawkeye Electric Manufacturing Company, of Oskaloosa, Ia., Mr. W. A. Durfee, president, has sold its entire business and goodwill to a concern of the same name of Davenport, Ia., of which Mr. M. L. Marks is president. At Davenport the company have taken the shops of the Donohue Foundry and Machine Works, and with a larger force will there carry on the business of manufacturing their system, with Mr. F. Thone as electrician.

South Omaha, Neb.—The South Omaha Electric Light, Heat and Power Company, whose formation has recently been noted, have a capital stock of $25,000. The officers are: J. F. Boyd, president; C. M. Hunt, vice-president; J. A. Doe, secretary, and J. F. Smith, manager. They are putting up a brick power house, 40 by 50, arranged for three boilers and two engines, and from six to eight dynamos. They begin with one boiler and one engine, and 35 arc light capacity of the Waterhouse system, which was selected after careful investigation.

Waco, Tex.—The Central City Westinghouse Electric Company, of which mention has already been made, has a capital stock of $30,000. The incorporators are M. D. Hering, S. Sanger, P. McClelland, T. Jones, J. I. Moore, J. B. Baker, W. H. Jones, J. A. Solomon and J. A. Blake, all of whom are well-known men in Waco. The negotiations have been carried through by Mr. T. T. Cronise, representing the Westinghouse Company, and it is expected to have the plant in operation by Christmas Day. The charter of the company is for a term of 50 years, and the local authorities have granted the various concessions asked for. The company will do a general light and power business.

Electricity for Yellow Fever.—A Kentucky physician suggests the following cure for yellow fever, claiming that the poison in the air is so delicate and subtle that it can be dissipated by strong light: "If this is a fact," says the doctor in a communication to Surgeon-General Hamilton, "I am of the opinion that if a row of large army tents were spread along the centre of some street in Jacksonville for the inhabitants to take refuge in, after having been thoroughly disinfected, with a sufficient number of electric lights arranged near the ground on either side of them (the wires, of course, being well grounded), that the lights could be made so intense as to repress the poison and stay the destroyer."

Danville, Pa.—A correspondent writes us follows: "On Sunday night, Oct. 28, a fire occurred in the engine and dynamo room of the Consumers' Gas Company, of this city. It occurred from a leak in an old fashioned gas sealer or valve that stood in the engine room; and the gas ignited from a gas jet at the steam gauge. It was necessary to turn the gas off from the street mains before the fire could be extinguished, and it was confined to the leak by the prompt action of the fire department. The city was without gas or electric light for the night, all the churches abandoning their night services. The dynamos, two 50-lighters of the American make, were found uninjured and were running again the next evening."

APPLICATIONS OF POWER.

Nashville, Tenn.—The McGavock and Mt. Vernon Street Railroad Company are to put on an electric motor car experimentally.

Steubenville, O.—The local electric light company is adding to its generating capacity for the purpose of operating the new electric road.

Auckland, N. Z.—Mr. Walter Prince is negotiating with the Auckland (New Zealand) Tramway Company, on behalf of the Thomson-Houston International Electric Company, to run their road by electricity.

Blackpool, England.—Mr. J. S. Lewis reports that the Blackpool electric road is doing well. Nine cars are constantly at work, running about 3,000 miles per week. Great improvements have been made in the method of insulating the conductor in the conduit.

A Strange Accident.—A special dispatch of Nov. 6 from Geneva, Switzerland, says: A reservoir at Montreux, on the Lake of Geneva, used to work an electric railway, burst to-day, destroying numerous houses and drowning many persons. Seven bodies have been recovered.

A Large Mather Motor.—The Mather Electric Company have recently put in a 30 h. p. motor at the grain elevator of W. H. Childs, Manchester, Conn. It is used for running the new process rolling mill lately put in. It is wound for a 220-volt current and is believed to believed to be the largest single motor operating in New England.

PERSONALS.

Mr. Paul Seiler has retired from the California Electrical Works of San Francisco.

Mr. J. B. Crouse, of the Standard Carbon Company, while in New York last week, reported that the demand on his company for carbons was larger than ever. The outlook for winter trade is excellent.

Mr. W. H. Cole has resigned his position as superintendent of the Virginia Electric Light & Power Co., and the Richmond Union Passenger Railway Co., of Richmond, Va., and has located in this city as a contracting electrical engineer.

Mr. T. Turner, the president of the American Gas Light Association, alluded at the recent Toronto meeting to the relations between gas and the electric light. He thought that electricity ought to have the credit of largely increasing the demand for light and hence for gas, but he was not in favor of a combination of the two interests. He did not see why a gas company should want to sell the electric light any more than it sells oil and candles.

Mr. George Watts, senior member of the firm of Watts, Campbell & Co., machinists, died suddenly on Nov. 3, at his home, No. 197 Broad street, Newark, N. J. He had started to accompany his employes on a target excursion to Greenville, and was taken sick at the railway station. The cause was apoplexy. Mr. Watts was born in Bristol, England, in 1820, and came to Newark with his parents. He built up an engine business which ranks high among its kind in this country. He leaves two sons and a daughter.

Col. George Gouraud, of Little Menlo, Norwood, England, Mr. Edison's representative abroad for the phonograph and other inventions, is the theme of a very interesting article in the Boston *Herald* of Nov. 4. Col. Gouraud is the son of Prof. F. Fauvel Gouraud, the friend of Daguerre, and his army career was an active one from the time when he was Gen. Gilmour's aide de camp at Fort Sumter in 1861, down to the close of the Civil War. Little Menlo is full not only of the wonders of modern science, but of relics and mementos of the war, and is a peculiarly attractive place of resort for Americans.

Mr. D. H. Louderback, so long and favorably known in the telephone business, has severed his connection with the various interests heretofore under his charge, and has removed to and taken up his residence at Tacoma, W. T., where he will engage in the smelting business together with capitalists from St. Paul and elsewhere. To Mr. Louderback's zeal and energy is due to a large extent the thrift and growth of the various telephone enterprises with which he was connected. He was the first to conceive the idea of consolidating the small companies heretofore in existence into a larger territory, thereby making many properties that had been previously unprofitable paying investments. It is a misfortune for the electrical industry to lose the active interest and assistance of a man so able.

MISCELLANEOUS NOTES.

Peoria, Ill.—The Royal Electric Company, of Peoria, is to build a factory for the making of electrical appliances.

The National Electric Construction Company, Limited, of New York City, has been formed by H. C. Comegys and others, with a capital stock of $20,000.

The Pacific Edison Phonographic Company has been incorporated by J. I. Sabin, R. T. Stevens, L. Glass, L. H Jacobi and others, with a capital stock of $720,000.

Chas. A. Schieren & Co., report sales of their electric perforated belting to twelve different electric light companies during the past month. The demand for this article is steadily increasing.

The Shaw Electric Crossing.—W. P. Shaw, A. X. Mackey and J. B. Livingstone are the incorporators of the Shaw Electric Crossing and Advance Signal Company of East St Louis, with a capital stock of $1,000,000.

The Crowdus Fare Box.—At the Texas State Fair and Exposition held at Dallas during the past month, the Electric Fare Box Company, of Nashville, Tenn., exhibited their Crowdus electric fare box, and received the first prize for fare boxes. Their box attracted such remarkable notice from visitors desirous of seeing and hearing the electric light and alarm, which is actuated by depositing a nickel in the box, that it was decided to donate all money deposited in it by visitors to the Buckner

Orphan Home of that city, and during the twenty-five days the exposition was open $100 a day was collected by their box.

BUSINESS NOTICES.

The Electrical Supply Company of Chicago are Western agents for the Paiste switch.

The Spencer Damper Regulator has been adopted for their four new boilers by the Cambridge, Mass., Electric Light Company, for controlling steam. It has also been adopted by the Quincy, Mass., Electric Light Company.

Jordan & Gottfried, 208 Canal Street, N. Y., carry a complete stock of iron and brass machine and wood screws, bolt, cap and set screws, taps, dies, files, twist drills, brass and rubber tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

The Link-Belt Machinery Company, of Chicago, have begun the erection of their new foundry to be located on their 5½ acre tract at Thirty-ninth street and Stewart avenue, Chicago. The structure will be 286 feet long by 87 feet wide, and will probably be completed before spring.

The Hussey Reheater.—Among the recent orders for Hussey reheaters, which reheat exhaust steam by means of the waste gases of combustion on their way from the boilers to the chimney, and are made by the Hussey Reheater and Steam Plant Improvement Company, 15 Cortlandt street, is one from the Phillipsburg, Pa., Electric Light Company.

The Schenck Belt-Holder and Shifter Company, 93 Liberty street, New York, report a renewed inquiry for their device for shifting dynamo belts. On account of its being a novelty in practical mechanics, many of the orders require the machines to be placed in particularly difficult positions, but further than slight delays the results are satisfactory.

The Partz Electric Battery Company, of Philadelphia, having found their old quarters at 1,723 Chestnut street too small, have leased the large building at 636 Arch street, same city. They are now prepared to fill all orders promptly, and in addition to their large line of Open Circuit and Gravity and Motor Batteries, have a full line of small Motors and Dynamos. Send for their price list and catalogue, or write to them, stating what you want.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

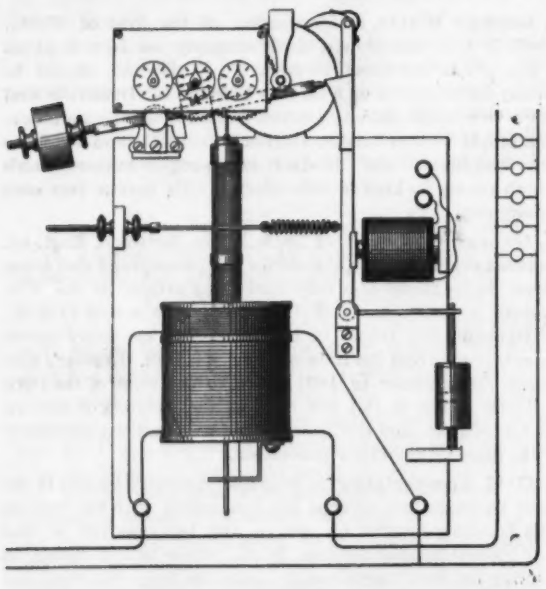
PATENTS ISSUED NOV. 6, 1888.

392,213. Transformation and Distribution of Electric Energy; William J. McElroy, Pittsburgh, Pa. Application filed March 12, 1888. A system of transformation of electric energy, consisting in communicating potential to one member of a condenser, and thereby inducing an equal potential on the other member, then effecting a change of potential in the latter, and finally discharging it at such changed potential. See illustration.

392,240. Electric Regulating and Hand Setting Mechanism for Clocks; William S. Scales, Somerville, Mass., Assignor to the Synchronous Time Company, of Portland, Me. Application filed Nov. 18, 1887. The invention consists of an electric circuit containing several clocks, each provided with a regulating device for the regulating member thereof, a circuit controlling device for rendering the circuit operative to permit an impulse to be transmitted to the several clocks to be regulated, and to transmit the impulse, and a master-clock for effecting the operation of the controlling device.

392,233. Mechanical Telephone; George F. Shaver, New York, N. Y., Assignor to the Shaver Corporation. Application filed March 31, 1888. An apertured sounding board under tension extends entirely over and supports the diaphragm.

392,244. Secondary Battery; H. Walter, Cincinnati, O., Assignor to J. R. Murdock. Application filed Aug. 18, 1887. A storage battery having electrodes, composed solely of solids,



392,437. ELECTRIC METER.

crushed or broken carbon, sufficient space being given for the proper circulation of the electrolyte in and around the pieces of carbon composing said electrode.

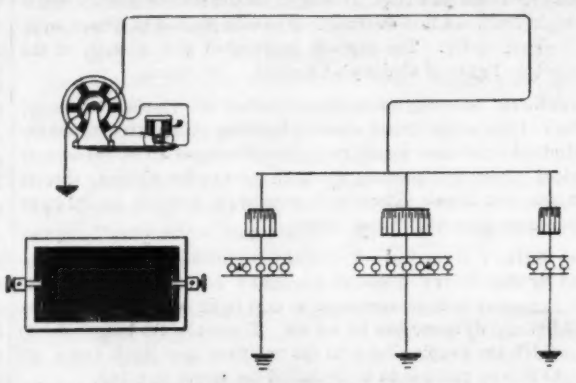
293,248. Police Alarm System; John C. Wilson, Boston, Mass., assignor to the Municipal Signal Co., of Portsmouth, N. H. Application filed Jan. 14, 1888. The invention consists of two or more metallic or signaling circuits having ground branches including telephones, a common ground branch for all the circuits, which includes a telephone, and a rotary switch operated by the movement of a pointer over a suitable dial or index for connecting said common ground branch with any one of the said signal circuits.

392,301. Telephonic Circuit; Robert M. Bailey, Williamsport, Penn., Assignor to the American Bell Telephone Company, of Boston, Mass. Application filed Aug. 2, 1888. The invention relates to the construction and arrangement of telephone circuits. The object is to place a number of telephone circuits in serial circuit with one another without subjecting the telephones of any of the stations to the retarding influence of the magneto-electric counter-currents, which influence necessarily is exerted when electro-magnets are interposed in the line at way stations.

392,326. Telephone Switch-Board; C. C. Gould, Batavia, N. Y., Assignor to the Eastern Electrical Manufacturing Co., of Wheatfield, N. Y. Application filed Dec. 22, 1887. The invention relates to an improvement in the class of telephone switch-board systems in which each subscriber's line is provided at the central office with a movable terminal which is automatically moved out of its normal position so as to break the ground connection upon sending a current through the line.

(1) 392,385. (2) 392,386. (3) 392,387. (4) 392,476. (5) 392,477, and (6) 392,478. Galvanometers; Edward Weston, of Newark, N. J., assignor to the Weston Electrical Instrument Company, of same place. Applications filed respectively April 9, 1888; April 14, 1888; March 17, 1888; Aug. 17, 1888; Aug. 17, 1888, and Aug. 17, 1888.
For description of voltmeter and ammeter see page 263 this issue.

392,393. Arc Lamp; John C. Young, Newark, N. J. Application filed Dec. 1, 1886. In the action of an arc lamp there is a period usually near the beginning of its life when it burns with its greatest effectiveness, while after that period there is a change in the action of the lamp, and the arc grows longer and burns with less steadiness. The means which are employed to overcome this defect consist of an endless chain passing around the wall of the tube within which the carbon is supported and attached to the carbon-carrier, the latter being at the top of the tube when the full-length carbon is inserted in place. The portion of the chain outside the tube is made substantially equal in weight to the carbon itself, and as the carbon feeds, enough of the chain is fed over the top of its

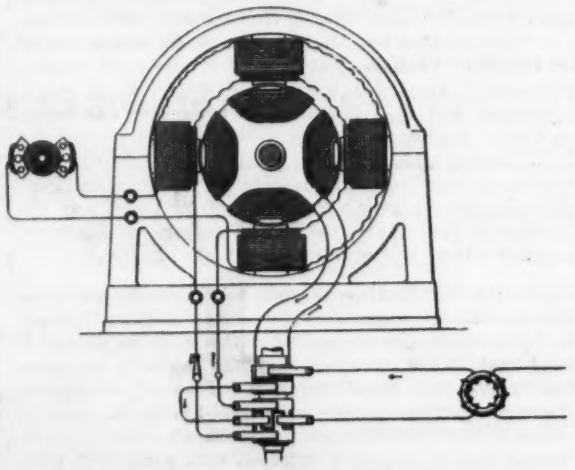


392,213. TRANSFORMATION AND DISTRIBUTION OF ELECTRIC ENERGY.

tube to compensate for the loss in the consumption of the carbon. A device for restoring the arc after it gets beyond its normal length, consists of a lever, the free end of which, when applied to a clutch-lamp, travels in the same direction as the clutch, but at a greater speed. The lever is set almost in contact with the clutch after the lamp has been adjusted to its proper length of arc, so that when the clutch is affected in such a manner as to lengthen the arc still further the lever will trip the clutch and cause it to feed while suspended. See illustration.

392,400. Electric Discharge Device; R. Belfield, Pittsburg, Pa., Assignor to the Westinghouse Electric Company, of same place. Application filed July 20, 1888. The invention consists in equipping the generator with discharge points which are supported by, but insulated from, the frame of the generator and directed toward the belt-wheel. These points are connected electrically with the earth. A harmless discharge may take place at all times from the pulley to the points, and thus to the earth or to the driving engine.

392,413. Switch-Board for Telephone Exchanges; Francis Blake, Weston, Mass. Application filed Aug. 10, 1888. The claim sets forth the invention as follows: In a switch-board for a telephone exchange, the combination, with the line wires of, first, the distributing board provided with terminals and grounded annunciators, one of each for each line wire; second, connecting tables through which the said line wires or subscribers' lines pass in groups to their respective terminals and annunciators at the said distributing board,



392,470. OPERATING ALTERNATE CURRENT MOTORS.

there being in each of said lines a spring jack at the connecting table through which the line thus passes, and, third, connecting strips between said distributing board and each of said connecting tables, each of said strips being provided with a connecting cord or similar terminal at each end, and also with an annunciator at its respective connecting table.

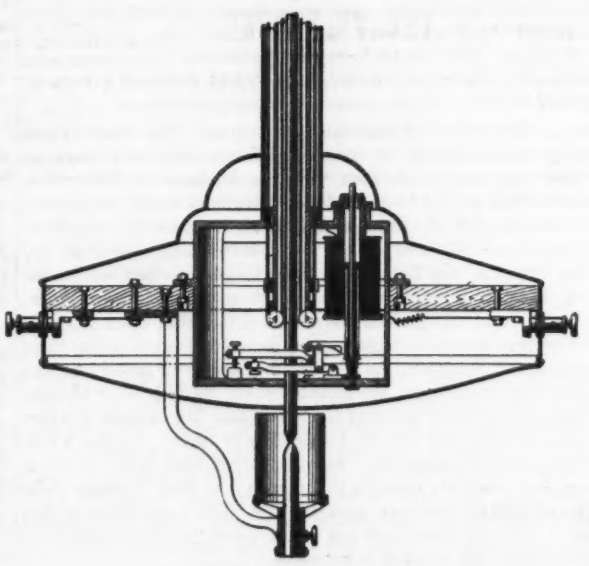
(1) 392,437. (2) 392,438. (3) 392,439. Electric Meters; P. Lange, Pittsburgh, Pa., Assignor to the Westinghouse Electric Company, of same place. Applications filed respectively, Jan. 21, 1888; March 20, 1888, and March 20, 1888. The combination with an electric meter and an electro-magnet for periodically operating the same, of a secondary electric clock actuated each time the meter is operated. See illustration.

392,440. Electric Gas Lighter; Joseph H. Lehman, Philadelphia, Pa. Application filed Dec. 20, 1887. An electric gas-lighter having a movable electrode adapted to be brought in contact with another electrode to create a spark at the burner tip, a lever for moving the electrode, and connecting devices between the lever and the electrode, whereby the electrode is prevented from operating at each alternate movement of the lever.

(1) 392,443. (2) 392,444. (1) Magneto Signaling Apparatus; (2) Railway Signal; M. W. Long, Harrisburg, Penn. Applications filed respectively Oct. 4, 1887, and May 11, 1888. A visual signal, and electric motor and intermediate gearing through which the continuing action of the motor moves the signal positively to its different positions, a distant magneto generator, suitable electric conductors connecting the generator and motor, and manual devices for operating the generator, whereby the attendant is enabled to generate and supply an electric current to set the distant signal in a positive manner.

(1) 392,470. (2) 392,471. (1) Operating Alternate Current Motors; (2) Alternate Current Electric Motor; William Stanley, Jr., Great Barrington, Mass., Assignor to the Westinghouse Electric Company, of Pittsburgh, Pa. Applications filed Dec. 9, 1887. A method of operating electric motors, which consists in bringing the motor to a synchronized speed by commutating currents to produce in the field magnet such a polarity as will cause a continuous torque between the armature and field magnets, and in supplying independent currents continuous in the direction, and thereby rendering the strength of the field magnet approximately constant. See illustration.

392,490. Commutator Bar for Dynamo-Electric Machines; C. E. Billings, Hartford, Conn. Application filed Dec. 4, 1886. As an article of manufacture a full sized commutator bar for dynamo electric machines which has two arms whose longitudinal axes form an angle with the other, and which is composed throughout of one single piece of unalloyed copper of an almost perfectly homogeneous molecular



392,393. ARC LAMP.

structure, the fibre or grain of the copper being so arranged as to be everywhere parallel with the axis of the arm and of the greatest possible density.

392,513. System of Incandescent Lighting; Charles Heisler, St. Louis, Mo., Application filed June 24, 1887. A system of incandescent electric lighting consisting of a main circuit supplied from an alternating current machine, a transformer in said main circuit, an induced circuit extending from said transformer, a regulator in connection with the main and induced circuit, a power device in connection with the shaft of the regulator for operating the same, and means for automatically releasing the power device on the switching in of the first lamp.

392,520. Arc-Light Carbon; James J. McTighe, Freeport, Pa. Application filed Feb. 24, 1886. A pencil electrode for electric lighting formed of natural gas hard carbon.

(1) 392,573. (2) 392,574. Electrode for Secondary Batteries; Charles H. Thompson, Detroit, Mich., Assignor to the Woodward Electrical Company, of same place. Applications filed March 9, 1888. A method of producing an electrode for a secondary battery, which consists in casting or molding a highly porous or cellular support with a solid terminal integral with the body thereof, then coating the support with active material or pressing it into the pores or cells thereof.

392,577. System of Electric Meters; Alexander Wurts, Pittsburgh, Penn., Assignor to the Westinghouse Electric Company, of same place. Application filed Jan. 21, 1888. The object of the invention is to provide convenient means whereby a system of meters may be controlled from one central point, so that each meter instead of being provided with separate actuating mechanism—such, for instance, as clock-works—may receive periodically from the central point or station the requisite impulses for effecting the indications or registrations.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had for 25 cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, N. Y.